OSTRICH
Vol. 65 Nos. 3 & 4
December 1994

OBSERVATIONS ON THE DIETARY CHOICE OF FREE-RANGING JUVENILE OSTRICHES

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Received May 1992

SUMMARY

COOPER, S.M. & PALMER, T. 1994. Observations on the dietary choice of free-ranging juvenile Ostriches. *Ostrich* 65: 251–255.

The dietary selection of juvenile Ostriches in an east African savanna was determined using penned and free-ranging chicks. The young Ostriches displayed an innate preference for selected plant species and showed little change in diet composition with increasing experience. The most heavily utilized foods were newly emergent grass leaves and the foliage of the woody forbs *Indigofera schimperi* (Leguminosae) and *Aspilia mossambicensis* (Compositae). While the diet composition of the Ostrich is similar to that of Grant's gazelle, Ostriches differ in that they eat some silica rich plants not utilized by ungulates; thus Ostriches may be a useful addition to mixed-species game ranching in Africa.

INTRODUCTION

While many studies have been conducted on the feeding ecology of African savanna ungulates (Vesey-FitzGerald 1960; Lamprey 1963; Talbot & Talbot 1963; Gwynne & Bell 1968; Bell 1970 & 1971; Owanga 1975; Jarman & Sinclair 1979; Stelfox 1985), few have acknowledged a potentially important herbivore, equivalent in body size to an impala *Aepyceros melampus* or Grant's gazelle *Gazella granti* — the Ostrich *Struthio camelus*. In fact very little has been published on the diet of wild Ostriches beyond incidental data on dead birds (Robinson & Seeley 1975; Kok 1980; Keffen & Jarvis 1984; Keffen 1984), and virtually nothing is known on the diets of wild juveniles. In the present study we examine the development of the diet composition of young Ostrichs in the wild and discuss the degree to which Ostriches display complimentary resource utilization with other large herbivores.

General physiological differences between birds and mammals suggest that the dietary requirements of the Ostrich may be somewhat different from those of the ungulates with which they coexist. Ostriches lack the complex stomach of the ruminant but have the long hind gut and double caecum common to herbivorous birds (McLelland 1979). Thus the pattern of digestion is more reminiscent of the monogastric ungulates than ruminants. However, the beak of an Ostrich allows it to feed very selectively. If the plant species selected by the Ostriches are different from those utilized by sympatric ungulates these birds may be a useful addition to mixed-species game ranching in Africa.

STUDY AREA AND METHODS

Study area

The study was conducted on a mixed cattle and game ranch located 40 km southeast of Nairobi, Kenya (01 30S 37 02E, altitude 1600 m a.s.l.). Bimodal precipitation averages 510 mm per annum. The Ostriches were kept in the ecotone between a strip of *Acacia xanthophloea* woodland and more open *Themeda-Acacia* scattered tree savanna (Pratt *et al.* 1966).

Acquisition and rearing of Ostriches

Two Ostrich chicks, aged one week, were captured from a local wild flock in October 1990. The chicks were fed on commercial chick mash with added calcium and fresh chopped leaves of *Brassica oleracea*. Initially the chicks were penned on a rough cut lawn, then at about 6 weeks old, after completion of the initial selection trial, they were allowed to roam freely. The chicks voluntarily joined a local flock of wild subadult Ostriches when 5 months old, thus terminating the feeding trials. We assumed that supplemental feeding during rearing had no appreciable effect on the diet selection of these Ostriches.

Pen trials

Innate food preference trials began two weeks after capture. Fresh cut branches of 18 common shrubs and woody forbs were offered to the penned chicks in random rotation over three trial periods. Each morning and evening, before the chicks were fed, branches of 3 randomly selected species, matched for size and shape, were tucked

into the wire mesh of the pen. Their response was recorded as follows:

1. Accept the branch readily and strip it of all easily available leaves.
2. Eat only a few leaves off the branch then walk away.
3. Peck off one or two leaves but spit them out without swallowing, this may be accompanied by vigorous shaking of the head.
4. Ignore the branch despite repeated introduction.

Feeding trials

Feeding trials began in November when the Ostriches were no longer penned. They were led to randomly selected areas early in the evening, when the daily temperature decreased and wild Ostriches were observed to be feeding. Focal animal sampling was conducted for periods of half an hour using each bird in rotation. Plant species selection, duration of feeding on individual plants, pecking rate and plant species availability, were assessed. For the latter, encounter rate was assessed as the presence of a plant species within a 0,5 m radius around the Ostrich's head, at intervals of 2 minutes, provided the bird was actively feeding at that moment. Preference for food plants was calculated using three indices (after Cooper & Owen-Smith 1987):

1. Proportion of the total feeding time allocated to each species.
2. The mean duration of feeding on individual plants of a species.
3. Acceptance value calculated as: number of plants eaten / number of plants encountered.

Feeding trials were conducted during the wet season from November to mid-December and in the dry season from late January through mid-February.

Quantifying food intake

Fresh cut branches of favoured species were weighed, then immediately presented to an Ostrich. After 10 bites the branches were promptly reweighed on site and the mean bite weight calculated. The branches were presented in random order over a period of days so that the chicks were never satiated during the test. Weights of bites of grass were calculated from hand simulated pecks after close observation of the Ostriches. Intake rate (gms/min) was calculated as mean bite weight × pecking rate.

RESULTS

Pen trials

Upon first exposure and in subsequent trials the young Ostriches readily ate the foliage of *Aspilia mossambicensis* and *Indigofera schimperi*. After some hesitation in the first trial, branches of *Phyllanthus parvus* were also stripped of leaves (Table 1).

Acacia drepanolobium leaves were eaten in small quantities, but only after the chicks had tasted leaves off dethorned branches. Mature leaves of *Acacia xanthophloea* were rejected but soft, new shoots were eaten. Other less favoured plants included *Asparagus africanum*, a spinescent creeper with fine filamentous leaves, and *Achyranthes aspera* which was eaten in decreasing quantities in each trial. The Ostriches were initially reluctant to take *Solanum incanum* but once tasted several leaves were eaten in subsequent trials. Individual variation between chicks was shown in their responses to *Abutilon mauritanium* and *Pavonia gallaensis*, both chicks took only single leaves, but the male swallowed the leaf while the female spat hers out.

TABLE 1
RESPONSE OF PENNED JUVENILE OSTRICHES TO NOVEL PLANT SPECIES.

	Male Ostrich			Female Ostrich		
Trials:	T1	T2	T3	T1	T2	T3
Favoured plant species						
Aspilia mossambicensis	1	1	1	1	1	1
Indigofera schimperi	1	1	1	1	1	1
Phyllanthus parvus	2	1	1	2	1	1
Less favoured plant species						
Acacia drepanolobium	4/2[d]	2	2	4/2[d]	2	2
Acacia xanthophloea	3	2[s]	2[s]	3	2[s]	2[s]
Achyranthes aspera	2	2	2*	2	2	4
Solanum incanum	2*	2*	2*	2*	2*	2*
Asparagus africanum	2	4	2*	2	3	2*
Non-favoured plant species						
Pavonia gallaensis	2*	2	2	3*	3	2
Abutilon mauritanium	3	2	2	3	3	3
Rejected/Ignored plant species						
Ipomea cicatricosa	3	3	3	3	3	3
Tagetes minuta	4	3	3	3*	3	3
Carissa edulis	3	3*	3*	3	3*	3*
Grewia similis	3	3*	4	3	3*	4
Datura stramonium	3	4	4	3	4	4
Hibiscus flavifolia	3*	4	4	3*	4	4
Asparagus cf. buchananii	4	4	4	3*	4	4
Balanites glabra	4[o]	4[o]	4[o]	4[o]	4[o]	4[o]

Key:
1 leaves eaten readily
2 some leaves eaten
3 tasted and rejected
4 ignored
[d] dethorned
[s] soft shoots
* initially refused
[o] old foliage

TABLE 2
PROPORTION OF THE TOTAL FEEDING TIME OF JUVENILE OSTRICHES ALLOCATED TO VARIOUS PLANT SPECIES.

Wet season		Dry season	
Primary plant species		Primary plant species	
Indigofera schrimperi	68,3%	*Indigofera schrimperi*	24,0%
Green grass	14,9%	Green grass	22,9%
Aspilia mossambicensis	11,6%	*Aspilia mossambicensis*	24,1%
Other plant species		Secondary plant species	
Phyllanthus parvus	0,9%	Grass seed	8,5%
Justicia diclipteroides	0,8%	*Commicarpus pedunculosus*	6,6%
Grass seed	0,5%	*Justicia diclipteroides*	4,1%
Raphanus raphanistrum	0,4%	*Tagetes minuta*	2,5%
Thunbergia spp.	0,4%	Other plant species	
Cyphostemmon hispidus	0,2%	*Acanthospermum hispidum*	0,7%
Pentanisia ouranogyne	0,2%	*Balanites glabra* (fruits)	0,4%
Crotilaria verdcourti	0,2%	*Antherium* spp. (seed)	0,4%
Other forbs	1,6%	*Cyphostemmon hispidus*	0,3%
		Dyschoriche radicans	0,3%
		Acanthospermum schimperi	0,2%
		Raphanus raphanistrum	0,2%
		Indigofera cf. *spicata*	0,2%
		Indigofera cf. *volksensii*	0,2%
		Thunbergia spp.	0,2%

Eight species were categorised as rejected. The Ostriches tasted and rejected *Carissa edulis, Grewia similis, Ipomea cicatricosa* and *Tagetes minuta*. The strongest negative reactions were given to *Asparagus buchananii, Datura stramonium, Hibiscus flavifolius* and the spiny, evergreen *Balanites glabra*.

Feeding trials

Newly emergent grass leaves and the foliage of the two of the common woody forbs *Indigofera schimperi* and *Aspilia mossambicensis*, both favoured in the pen trials, took up 95% of the Ostriches' feeding time in the wet season (Table 2). Mature grass leaves were not eaten. When the availability of *I. schimperi* leaves decreased in the dry months the Ostriches compensated by doubling the time spent feeding on *A. mossambicensis* and new grass. They also began to make more use of grass seed, and soft forbs especially *Commicarpus pedunculosus, Justicia diclipteroides* and seedlings of *T. minuta*. Many other species were included in the diet but none occupied more than 1% of the feeding time.

Feeding duration

The duration of feeding on any individual plant never exceeded 3 minutes. The Ostriches fed longest on individual plants of *I. schimperi* and *A. mossambicensis*, indicating their favoured status. (Table 3). The mean feeding duration on plants of *I. schimperi* was significantly longer than on *A. mossambicensis* in the wet season ($t = 3,400$; $n = 225$ $P < 0,001$), but this difference became less apparent in the dry season due to a slight reduction in feeding duration on *I. schimperi* ($t = 0,849$; $n = 261$) coupled with a minor increase in duration of feeding on *A. mossambicensis* ($t = 0,763$; $n = 156$). *C. pedunculosus* entered the diet in the dry season and was browsed on for comparatively long durations. Although favoured in the pen trials, plants of *P. parvus* were eaten for appreciably shorter durations than either *I. schimperi* ($t = 5,154$; $n = 182$; $P < 0,001$) or *A. mossambicensis* ($t = 2,723$; $n = 61$; $P = 0,01$–$0,001$). Plants of many less favoured species warranted only a single bite.

Acceptance

The Ostriches showed the highest acceptance values (>3) for *I. schimperi* (Table 4). Acceptance of *A. mossambicensis* was moderate at 1,1 in the wet season but rose significantly to 3,0 in the dry months ($\chi^2 = 14,387$; $P < 0,001$). *J. diclipteroides* showed a similar seasonal trend but was somewhat less favoured with acceptance values of 0,6 in the wet season rising to 2,0 in the dry season ($\chi^2 = 8,490$; $P = 0,01$–$0,001$). *C. pedunculosus* and *T. minuta* were not available in the wet season but had acceptance values in line with *J. diclipteroides* in the dry season. Non-favoured plants with acceptance values below 1 include *A. aspera, P. gallaensis, P. parvus* and *S. incanum*. Although encountered less than 5 times during the trials *A. xanthophloea, C. edulis* and *G. similis* probably fall into this category. Species often encountered but not observed to be eaten have an acceptance value of zero. These include *A. mauritianum, A. drepanolobium, Asparagus* spp. and *H. flavifolius*.

TABLE 3
MEAN DURATION (SECONDS) OF FEEDING ON INDIVIDUAL PLANTS OF EACH SPECIES.

Plant species	Wet season			Dry season		
	Mean	sd	n	Mean	sd	n
Indigofera schrimperi	23,8	±29,8	173	20,2	±23,9	88
Aspilia mossambicensis	14,8	±13,7	52	17,0	±19,9	104
Green grass	8,7	±18,4	102	12,3	±14,0	138
Grass seed	9,0	± 5,0	3	12,6	±14,2	50
Justicia diclipteroides	3,9	± 2,4	12	10,4	± 7,4	29
Phyllanthus parvus	6,2	± 7,6	9	1,0	± 0,0	1
Commicarpus pedunculosus	not available			41,0	±46,3	12
Tagetes minuta	rejected		1	8,0	± 8,9	23
All other forbs	4,0	± 3,4	24	5,5	± 7,0	55

TABLE 4
ACCEPTANCE VALUES OF PLANTS ENCOUNTERED BY FREE RANGING OSTRICH CHICKS.

	Wet season		Dry season	
Common plant species	acceptance value	# plants available	acceptance value	# plants available
Indogefera schrimperi	3,1	55	3,5	25
Aspilia mossambicensis	1,1	48	3,0	35
Justicia diclipteroides	0,6	22	2,0	15
Commicarpus pedunculatus	not available		2,4	5
Tagetes minuta	not available		1,9	12
Phyllanthus parvus	0,4	21	0,1	12
Bothriocline calycina	0,0	9	0,1	11
Hibiscus flavifolius	0,0	7	0,0	6
Hypoestes hildebrandti	0,0	11	0,0	9

	Combined seasons	
Other plant species	acceptance value	# plants available
Thunbergia spp.	1,3	8
Cyphostemmon hispidus	1,0	5
Balanites glabra	0,5	2
Crotilaria verdcourti	0,4	5
Grewia similis	0,5	4
Carissa edulis	0,3	3
Acacia xanthophloea	0,3	4
Solanum incanum	0,2	5
Rhynchosia minima	0,2	11
Achyranthes aspera	0,1	9
Pavonia gallaensis	0,1	11
Abutilon mauritianum	0,0	9
Acacia drepanolobium	0,0	4
Asparagus africanum	0,0	6
Commelina spp.	0,0	8

Food intake rate

The food intake rate of the chicks averaged 10,4 gm/min fresh weight when feeding on *A. mossambicensis* and 9,3 gm/min for *I. schimperi* (Table 5). In comparison the intake rate for newly emerged grass leaves was only 1,3 gm/min. Thus the foraging efficiency, as measured by the rate of food intake, was far greater when eating forbs rather than grass.

DISCUSSION

The diet of juvenile Ostriches in *Acacia-Themeda* savanna consisted of selected forbs and new grass, with some seeds and fruit when available. When first introduced to a variety of plant species the chicks showed strong preference responses, which were maintained throughout the study. Thus the selection of food plants seems to be innate in precocial birds as it is in antelope (Frost 1981). Admittedly the chicks had run with their parents for about a week before capture but it is unlikely that they had encountered many of the plants presented to them. Selection appeared to be primarily visual, the chicks were attracted to dark green foliage and plants resembling known palatable species (initially *Brassica*). The secondary response was taste. Plants discovered to be distasteful were rejected thereafter.

The penned chicks had an immediate liking for *I. schimperi* and *A. mossambicensis* and retained this preference throughout the study. Together with new grass leaves these two species occupied 95% of the feeding time in the wet months, decreasing slightly in the dry months when the foliage of the favourite, *I. schimperi*, was less abundant. Initially the penned chicks also ate *P. parvus* (Euphorbiaceae) but unlike the previous species this preference was not maintained. Spinescent species were not well received possibly because of the danger of damage to the eyes. The Ostriches closed their nictitating membrane when pushing their heads into vegetation to feed. Of the species tasted and rejected by the chicks none except *T. minuta* became a significant food plant in the dry season. This species together with *C. pedunculosus* and *J. diclipteroides* compensated for the decrease in *I. schimperi* leaves in the dry season. Less favoured species may be more heavily utilized in times of food stress as is the case with browsing antelope (Frost 1981; Owen-Smith & Cooper 1987). For instance it is known that Ostriches do feed on highly spinescent *Acacia* plants in the Namib Desert Park (Robinson & Seeley 1975). None of the plants shunned by the penned Ostriches were seen to be eaten when encountered in the wild.

The young Ostriches selected a protein rich diet. When eating grass they chose only the most nutritious newly emergent blades (Boutton *et al.* 1988) and ripe grass seed stripped from the inflo-

TABLE 5
INTAKE RATE (G/MIN) ACHIEVED BY JUVENILE OSTRICHES WHEN FEEDING ON MAJOR FOOD PLANTS.

	Bites per minute			Bite size (g)			Intake
Plant species	mean	sd	n	mean	sd	n	mean
Indigofera schimperi	51,9	±12,9	126	0,18	±0,07	15	9,4
Aspilia mossambicensis	56,2	±15,3	56	0,18	±0,07	10	10,3
New grass	88,0	±34,6	63	0,02	±0,01	100	1,3

rescences. Forbs generally contain more protein and calcium than grasses but many possess toxic defence compounds (Dougall *et al.* 1964; Boutton *et al.* 1988). *I. schimperi* is a legume and as such is comparatively rich in protein and other nutrients, especially calcium. Plants of the favoured genera *Commicarpus* and *Justicia* also contain high levels of nutrients (Dougall *et al.* 1964). These plants are utilized by a variety of mammalian browsers (Kuchar 1981; Reed 1983). *A. mossambicensis*, on the other-hand, is a composite low in fibre, thus nutritious, but has a high silica content of almost 5% dry weight, similar to that found in grasses but distributed as hard granules on the leaf surface. On average the leaves and shoots of Kenyan browse plants contain 0,5–1,5% dry weight of silica (Dougall *et al.* 1964). The hard, gritty textured leaves of *A. mossambicensis* are not favoured by ungulates possibly because silica wears down the teeth and depresses digestion in the rumen (Van Soest & Jones 1968; McNaughton *et al.* 1985). Ostriches grind their food by means of stones in the gizzard (McLelland 1979), thus are less likely to be deterred by this substance. The use of Ostriches to eat and thus possibly repress the invasive woody forb *H. flavifolius* is not feasible. Like most ungulates (Kuchar 1981), the young Ostriches ignored the fibrous leaves of this common problem plant.

Ostriches obviously compete with ungulates in their utilization of green grass. However, grass occupied only one fifth of the chicks feeding time and the foraging efficiency was low compared to that achieved from forbs. Many of the genera of browse species selected by the Ostriches, with the exception of *A. mossambicensis*, were also palatable to ungulates (Kuchar 1981; Reed 1983). Dietary overlap is probably greatest between Grant's gazelle and Ostriches since both prefer a more open, arid habitat than the woodland dwelling impala (Talbot & Talbot 1962; Stewart & Stewart 1972; Spinage *et al.* 1980). Giraffe in *Acacia* savanna feed largely on spinescent species avoided by the Ostriches (Pellew 1984).

Although Ostriches may compete with gazelle in their use of grasses and some browse species, a considerable portion (approximately 12–24%) of the diet of the young Ostriches studied comprised of silicaceous species unused by ungulates. If this behaviour continues into adult life then the inclusion of Ostriches on rangelands may enhance the productivity of those ranches should game farming become an accepted practice in Kenya.

ACKNOWLEDGMENTS

This project was conducted at Game Ranching Ltd. owned by Dr. D. Hopcraft, to whom we should like to extend our thanks for permission to use his land and rear two Ostrich chicks from his wild flock. Finance was provided by the School for Field Studies, U.S.A.

REFERENCES

BELL, R.H.V. 1970. The use of the herb layer by grazing ungulates in the Serengeti. *In:* WATSON, A. (Ed.) Animal populations in relation to their food resources. Oxford: Blackwell Scientific Press: 111-123.

BELL, R.H.V. 1971. A grazing ecosystem in the Serengeti. *Sci. Amer.* 224:86-93.

BOUTTON, T.W., TEISZEN, L.L. & IMBAMBA, S.K. 1988. Seasonal changes in the nutrient content of East African grassland vegetation. *Afr. J. Ecol.* 26:103-115.

COOPER, S.M. & OWEN-SMITH, N. 1987. Assessing food preferences of ungulates by acceptability indices. *J. Wildl. Manage.* 51:372-378.

DOUGALL, H.W., DRYSDALE, V.M. & GLOVER, P.E. 1964. The chemical composition of Kenya browse and pasture herbage. *E. Afr. Wildl. J.* 2:86-121.

FROST, S.K. 1981. Food selection in young naive impala *Aepyceros melampus*. *S. Afr. J. Zool.* 16:123-124.

GWYNNE, M.D. & BELL, R.H.V. 1968. Selection of vegetation components by grazing ungulates in the Serengeti National Park. *Nature* 220:390-393.

JARMAN, P.J. & SINCLAIR, A.R.E. 1979. Feeding strategy and the pattern of resource partitioning in ungulates. *In:* SINCLAIR, A.R.E. & NORTON-GRIFFITHS, M. (Eds). Serengeti: dynamics of an ecosystem. Chicago: University of Chicago Press: 130-163.

KEFFEN, R.H. 1984. Diet of the Ostrich. *Tshomarelo News* 18:16.

KEFFEN, R.H. & JARVIS, M.J.F. 1984. Ostrich postmortem. *Tshomarelo News* 15:21.

KOK, O.B. 1980. Voedselinname van volstruise in die Namib-Naukluftpark, Suidwes-Afrika. *Madoqua* 12(3):155-161.

KUCHAR, P. 1981. The plants of Kenya: A handbook of uses and ecological status. Nairobi: Ministry of Environmental and Natural Resources, (K.R.E.M.U.) Tech. Rep. Series I.

LAMPREY, H.F. 1963. Ecological separation of the large mammal species in the Tangangire Game Reserve, Tanganyika. *E. Afr. Wildl. J.* 1:63-92.

MCLELLAND, J. 1979. Digestive system. *In:* KING, A.S. & MCLELLAND, J. (Eds). Form and function in birds. New York: Academic Press. Vol. 1:69-181.

MCNAUGHTON, S.J., TARRANDTS, J.L., MCNAUGHTON, M.M. & DAVIS, R.H. 1985. Silica as a defence against herbivory and a growth promoter in African grasses. *Ecology* 66:528-535.

OWANGA, M.L. 1975. The feeding ecology of wildebeest and zebra in Athi-Kaputei plains. *Afr. Wildl. J.* 13:375-383.

OWEN-SMITH, N. & COOPER, S.M. 1987. Palatability of woody plants to browsing ruminants in a South African savanna. *Ecology* 68:319-331.

PELLEW, R.A. 1984. The feeding ecology of a selective browser, the giraffe (*Giraffa camelopardalis tippelskirchi*). *J. Zool. Lond.* 202:57-81.

PRATT, D.J., GREENAWAY, P.J. & GWYNNE, M.D.A. 1966. A classification of East African rangeland, with an appendix on terminology. *J. Appl. Ecol.* 3:369-382.

REED, J.D. 1983. The nutritional ecology of game and cattle on a Kenyan ranch. Unpublished PhD Thesis, Cornell University, U.S.A.

ROBINSON, E.R. & SEELEY, M.K. 1975. Some food plants of ostriches in the Namib Desert Park, South West Africa. *Madoqua* 11(4):99-100.

SPINAGE, C.A., RYAN, C. & SHEDD, M. 1980. Food selection by the Grant's gazelle. *Afr. J. Ecol.* 18:19-25.

STELFOX, J.B. 1985. Mixed-species game ranching on the Athi-Plains, Kenya. Unpublished PhD thesis, University of Alberta, Edmonton.

STEWART, D.R.M. & STEWART, J. 1972. Comparative food preferences of five East African ungulates at different seasons. *In:* DEFFEY, E. & WATTS, A.S. (Eds). The scientific management of animal and plant communities. Oxford: Blackwell Scientific Publications: 351-366.

TALBOT, L.M. & TALBOT, M.H. 1962. Food preferences of some East African wild ungulates. *E. Afr. Agric. For. J.* 27:131-138.

VAN SOEST, P.J. & JONES, L.H.R. 1968. Effect of silica in forages upon digestibility. *J. Dairy Sci.* 51:1644-1648.

VESEY-FITZGERALD, I.D.E.F. 1960. Grazing succession among East African game animals. *J. Mammal.* 41:161-172.