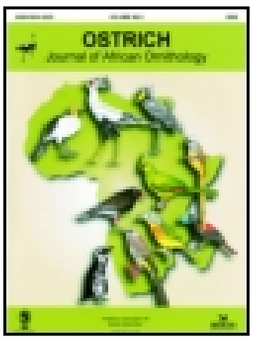

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FOOD HABITS OF THE MADAGASCAR LONG-EARED OWL *ASIO MADAGASCARIENSIS* IN TWO HABITATS IN SOUTHERN MADAGASCAR

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SUMMARY

GOODMAN, S. M., LANGRAND, O. & RAXWORTHY, C. J. 1993. Food habits of the Madagascar Long-eared Owl *Asio madagascariensis* in two habitats in southern Madagascar. *Ostrich* 64: 79–85.

Food remains recovered from regurgitated pellets of the Madagascar Long-eared Owl *Asio madagascariensis* were collected at two sites on Madagascar with different habitats and weather regimes. The localities are Beza Mahafaly, a sub-arid thorn scrub area in the southwest, and Bezavona Forest, a lower montane rain forest in southeastern Madagascar. At Beza Mahafaly prey composition varied according to season. Vertebrate prey included: frogs, lizards, birds, terrestrial insectivores, bats, lemurs and rodents. The total biomass of lemurs (*Microcebus*) represented varies from approximately 8 to 40%. Two samples from the Bezavona Forest included: frogs, geckos, birds, bats, lemurs and rodents. Lemurs (*Microcebus* and either *Hapalemur* or *Avahi*) made up a total biomass of 24 % at this locality. At both sites a significant proportion of the diet is composed of introduced rodents.

RÉSUMÉ

Les résidus alimentaires issus de pelotes de régurgitation de Hibou de Madagascar *Asio madagascariensis* collectées dans deux localités de Madagascar qui diffèrent par leur situation climatique et la nature de leur couverture végétale sont ici décrits. Ces deux localités sont Beza Mahafaly situé dans le bush sub-aride dans la partie méridionale de l'île et la forêt de Bezavona, forêt de basse altitude localisée dans le sud-est de Madagascar. Les trois lots de pelotes collectés au cours d'une année à Beza Mahafaly ont recélés une variété d'espèces de vertébrés parmi lesquelles des grenouilles, des lézards, des oiseaux, des insectivores terrestres, des chauve-souris, des rongeurs et des lémuriens. Ces échantillons montrent une variation saisonnière dans le choix des proies. La part de la biomasse totale constituée par les lémuriens représentés (*Microcebus*) varie d'environ 8% à 40%. Les deux échantillons du site de Bezavona analysés comprennent des grenouilles, des geckos, des oiseaux, des chauve-souris, des lémuriens (deux espèces) et des rongeurs. Les lémuriens (*Microcebus* et *Hapalemur* ou *Avahi*) représentent environ 24% du total de la biomasse au niveau de ce site. Une part significative du régime alimentaire de ce rapace nocturne au niveau des deux localités est constituée par des rongeurs introduits.

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INTRODUCTION

Little is known about the food habits of Madagascar raptors. The majority of information available is based on examination of stomachs of a limited number of specimens. Rand (1936) and Langrand (1990) present the current state of knowledge on the food habits of these birds. An exception is the endemic Madagascar Long-eared Owl *Asio madagascariensis*, for which regurgitated pellets were collected in lowland eastern humid forest in the southeastern corner of the island (Goodman *et al.* 1991). It was found that this owl takes a variety of vertebrates, including frogs, geckos, birds, bats, rodents, and lemurs (*Microcebus*).

In this paper we expand the previous report on the food habits of *Asio madagascariensis*, including additional material collected at the eastern humid forest roost described above (Goodman *et al.* 1991) and from a new site of sub-arid thorn scrub in the southwest. These new data provide insight into geographical and temporal variation in feeding habits of this owl.

STUDY AREAS AND METHODS

The material (regurgitated pellets) reported herein was collected in two areas in the southern portion of Madagascar (Toliara Province) in different biomes. The first site is in the southwestern portion of the island, near the Réserve Spéciale de Beza Mahafaly (23 38 -23 42 S and 44 31 -44 34 E), located 17 km east of Betioky (Nicoll & Langrand 1989). The reserve lies between 100 and 200 m above sea-level. The general habitat of this area is typical of sub-arid thorn scrub of the Southern Domain (Nicoll & Langrand 1989). The habitat in which the owl pellets were collected is mostly gallery forest located along perennial and periodic water courses on alluvial soils. This forest is dominated by *Tamarindus indica* which reach an average height of 15 m. Other common plants include: *Quivisianthe papinae*, *Byttneria voulily*, *Terminalia tricristata*, and several species of *Grewia* and *Marsdenia* (Phillipson 1987). Just outside the reserve boundaries, there are numerous villages, and these areas have been partially degraded by human activities.

The Beza Mahafaly area is characterized by cool winters, hot summers, and a small amount of erratic precipitation (at Betioky on average 550 mm per year); rain if it falls, usually arrives between November and March. Summer temperatures vary from 42°C during the day to 21°C at night and winter temperatures from 36°C to 3°C

TABLE 1
MEAN BODY MASS (G), RANGE AND SAMPLE SIZES (N) OF ANIMALS IDENTIFIED FROM PREY REMAINS.

Taxa	n	mean mass	range
Amphibia			
Ptychadena mascareniensis	9	4,9	3,0-6,5
Boophis madagascariensis	10	10,6	7,0-16,0
Platypelis grandis	1	58	
Reptilia			
Uroplatus sikorae	9	24,2	15-38
Paroedura bastardi	9	6,3	4,0-9,0
Aves			
Centropus toulou	5	215,0	130-220
Otus rutilus	5	103,0	85-116
Eurystomus glaucurus	1	180	
Hypsipetes madagascariensis	31	44,9	33,0-52,0
Foudia madagascariensis	22	16,9	13,0-19,5
Mammalia			
Suncus murinus	17	33,9	21,5-48,4
Geogale aurita	2	7,3	7,0-7,5
Tadarida jugularis	43	10,0	8,4-11,5
Hipposideros commersoni	5	59,0	39,8-68,1
Hapalemur griseus	4	830	737-1004
Microcebus rufus	28	47,5	35-70
Microcebus murinus	163	60	39-98
Rattus rattus			
combined	63	102,7	26,1-174,3
sub-adult	7	45,4	26,1-56,1
adult	56	109,9	66,0-174,3
Mus musculus			
combined	21	9,7	4,5-16,6
sub-adult	3	5,0	4,5-5,4
adult	17	11,5	6,5-16,6
Eliurus myoxinus	25	82,0	68-110
Eliurus minor	23	34,0	25-43,5

All mass measurements are based on our own field work on Madagascar with the exception of rodents, bats and some insectivores (specimens in National Museum of Natural History, Washington, D.C.), *Hapalemur griseus* (Tattersall 1982), *Microcebus rufus* (Harcourt 1987), and *M. murinus* (Martin 1973).

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respectively (Richard *et al.* 1991). Many of the animals living in this area have adaptations to deal with the severe climatic conditions.

On 16 June 1990, OL and Sheila O'Connor located two *Asio madagascariensis* perched 6 m up in a tree along the bank of the dry Ehazoara River, a tributary of the Sakamena River. The forest in the immediate vicinity of the perch was relatively intact (excluding a few domestic animal trails), the understory clear, and the ground covered with dead leaves. Pellets were collected at this site on three occasions in 1990: 16 June, 2 November, March-April. Pellets were generally intact or partially disintegrated.

The second locality is the Bezavona Forest, in the southeastern portion of the island, located 1,5 km northeast of the village of Nahampoana and 7,5 km north-northwest of Toalanaro (Fort Dauphin), at 24 58 S, 46 58 E and approximately 75 m above sea-level. The Bezavona Forest (also locally known as the Lakandava Forest) is located at the southern end of the Vohimena Range of the Anosyenne Mountain chain, and the vegetation in the vicinity of the owl roost is typical of lower montane zone of the eastern humid forest (Paulian *et al.* 1973). The specific setting of this site has been described by Goodman *et al.* (1991).

Seasonal shifts in climate, particularly precipitation, are not as marked at the Bezavona Forest as at Beza Mahafaly. The immediate region around the Bezavona Forest receives about 1200 mm of rain per year (Ratsivalaka-Randriamanga 1987). Pellet remains were collected between 27 and 30 December 1989 and between 17 September and 13 October 1990. The first collection was reported on by Goodman *et al.* (1991). Material from this site comprised mostly complete or partially dissolved pellets collected directly below the roost.

Paired elements of any taxon recovered from the pellets were separated and the largest number of elements of either the left or right side was considered the minimum number of individuals (MNI). Information about the species and habits of animals occurring at Beza Mahafaly and the Bezavona Forest is partially based on our own unpublished observations.

Body mass data for the animals identified from the food remains is given in Table 1. Mass data for *Asio madagascariensis* was not available in the literature, nor from examined museum specimens. *A. madagascariensis* and *A. otus* are approximately the same size. The latter species shows sexual dimorphism, and the mean body mass of males of the European population is 247 g (n=14) and females 305 g (n=19) (Fry *et al.* 1988). *A. madagascariensis* shows the same reversed sexual dimorphism, and it is reasonable to assume that the body mass of *A. madagascariensis* is approximately that of *A. otus*.

RESULTS

Beza Mahafaly

Animals represented in the Beza Mahafaly material consisted of a wide variety of vertebrates,

TABLE 2
VERTEBRATES IDENTIFIED FROM *ASIO MADAGASCARIENSIS* FOOD REMAINS COLLECTED AT BEZA MAHAFALY.

Sample Dates & Taxa	MNI[1]	% total individuals	% total biomass
2 November 1990			
Ptychadena mascareniensis	1	4,2	0,3
Paroedura bastardi	4	16,7	1,6
Microcebus murinus	2	8,3	7,8
Rattus rattus			
sub-adult	6	25,0	17,8
adult	10	41,7	71,7
Mus musculus			
adult	1	4,2	0,8
March-April 1990			
Hypsipetes madagascariensis	1	2,6	1,9
Foudia madagascariensis	1	2,6	0,7
Suncus murinus	2	5,3	2,8
Geogale aurita	2	5,3	0,6
Microcebus murinus	10	26,3	24,9
Rattus rattus			
sub-adult	7	18,4	13,2
adult	12	31,6	54,7
Mus musculus			
sub-adult	1	2,6	0,2
adult	2	5,3	1,0
16 June 1990			
Tadarida jugularis	9	56,3	15,1
Microcebus murinus	4	25,0	40,3
Rattus rattus			
sub-adult	1	6,3	7,6
adult	2	12,5	36,9
Summary			
Amphibia	1	1,2	0,1
Reptilia	4	5,1	0,5
Aves	2	2,5	1,4
Insectivora	4	5,1	1,8
Chiroptera	9	11,5	2,0
Microcebus murinus	16	20,5	21,2
Rattus rattus	38	48,7	72,1
Mus musculus	4	5,1	0,8

[1] MNI = Minimum number of individuals. See methods for precise definition.

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including frogs (*Ptychadena*), lizards (*Paroedura*), birds (*Hypsipetes*, *Foudia*), Insectivores (*Suncus*, *Geogale*), bats (*Tadarida*), lemurs (*Microcebus*), and rodents (*Rattus*, *Mus*). The MNI from the three combined Beza Mahafaly samples was 78 (Table 2). The most common prey by number were *Rattus* (48,7%), *Microcebus* (20,5%), and *Tadarida* (11,5%). Moreover, two animals comprised over 93% of the total biomass - *Rattus* (72,1%) and *Microcebus* (21,2%).

In the three samples there is variation in prey taken, which may be related to seasonality. In November 1990, 24 animals were identified. By number frogs and lizards made up 20,9%, lemurs 8,3%, and rodents 70,9%, and by biomass the figures are 1,9%, 7,8%, and 90,3% respectively.

No lizard or frog was represented in pellets collected in March-April. During this period birds made up 5,2% by number and 2,6% by biomass, while Insectivores comprised 10,6% and 3,4% respectively. The major shift is towards consuming more *Microcebus*, which in the March-April sample represented approximately 25% by both number and biomass. This increase in lemur consumption coincided with a reduction in the number of rodents eaten, their numbers dropped 13% and their biomass 21% from the November sample. In both samples, about one-third of the *Rattus* preyed upon were sub-adults.

The pellet material collected in June lacked frogs, lizards, birds and terrestrial insectivores, and comprised only bats, lemurs, and rodents, 56,3, 25,0 and 18,8% by number and 15,1, 40,3 and 44,5% by biomass respectively. There appears to be a shift towards *Microcebus* between November and June, from less than 8% of the biomass to over 40%. Two of the ten *Microcebus* recovered from the March-April sample were juveniles.

Bezavona Forest

A variety of vertebrates was found in the sample, including frogs (*Boophis*, *Platypelis*), lizards (*Uroplatus*), birds (*Hypsipetes*, *Centropus*, *Otus*), bats (*Hipposideros*), lemurs (*Microcebus*, *Hapalemur* or *Avahi*), and rodents (*Rattus*, *Mus*, *Eliurus* spp.). One calcaneus of a medium-sized lemur was recovered from the pellet remains that appears to be of an adult *Hapalemur griseus*, but because of damage to the cuboid facet of this specimen it is difficult to separate from *Avahi laniger* (Ian Tattersall, in litt.). Both lemur species occur in the Bezavona Forest. The body mass of *Hapalemur griseus* varies between 737-1004 g and *Avahi laniger* between 900-1 200 g (Ganzhorn *et al.* 1985; Petter *et al.* 1977; Tattersall 1982). Since the mass of these two species is approximately the same, the relative proportion of the total biomass represented in the sample by this single calcaneus is similar regardless of which species is involved.

TABLE 3
VERTEBRATES IDENTIFIED FROM *ASIO MADAGASCARIENSIS* FOOD REMAINS COLLECTED AT THE BEZAVONA FOREST, NEAR NAHAMPOANA.

Inclusive sample dates & taxa	MNI[1]	% total individuals	% total biomass
27 to 30 December 1989[2]			
Boophis madagascariensis	2	8	1,2
Uroplatus sikorae	2	8	2,8
Eurystomus glaucurus	1	4	10,4
Hypsipetes madagascariensis	1	4	2,6
Hipposideros commersoni	1	4	3,4
Microcebus cf. *rufus*	3	12	8,2
Rattus rattus	6	24	35,6
Eliurus myoxinus	6	24	28,4
Eliurus minor	3	12	5,9
17 September to 13 October 1990			
Boophis madagascariensis	1	3	0,2
Platypelis grandis	1	3	2,2
Uroplatus sikorae	5	17	4,6
Centropus toulou	1	3	8,2
Otus rutilus	1	3	3,9
cf. *Hapalemur griseus*	1	3	31,7
Microcebus cf. *rufus*	1	3	1,8
Rattus rattus			
sub-adult	7	23	12,2
adult	1	3	4,2
no teeth	7	23	27,5
Mus musculus	2	7	0,7
Eliurus minor	2	7	2,6
Summary			
Amphibia	4	7,2	2,0
Reptilia	7	12,7	3,9
Aves	4	7,2	12,6
Chiroptera	1	1,8	1,4
Microcebus cf. *rufus*	4	7,2	4,4
cf. *Hapalemur*	1	1,8	19,2
Rattus rattus	21	38,2	40,8
Mus musculus	2	3,6	0,4
Eliurus spp.	11	20,0	15,3

[1] MNI = Minimum number of individuals. See methods for precise definition.
[2] The information from this period is based on Goodman *et al.* (1991).

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The MNI for the combined Bezavona Forest samples was 55 (Table 3). The most common prey by number were *Rattus* (38,2%), *Eliurus* spp. (20,0%), Amphibia (7,2%), Reptilia (12,7%), *Microcebus* (7,2%) and birds (7,2%) and by biomass *Rattus* (40,8%), *Eliurus* spp. (15,3%), birds (12,6%), and *Microcebus* (4,4%).

The two samples from Bezavona Forest were taken during approximately the same season, one year apart, and little variation in the types and proportions of prey taken is seen between them. In the late December 1989 sample a MNI of 25 different animals was identified from the remains, representing frogs, lizards, birds, a bat, lemurs, and rodents. By number and biomass rodents constituted 60% & 70%, frogs and lizards 16% & 4%, lemurs 12% & 8%, birds 8% & 13%, and bats 4% & 3% respectively.

The second sample collected between 17 September and 13 October 1990 consisted of a MNI of 30, including the same groups found in the December 1989 sample except bats. Differences between the 1990 and 1989 samples were the presence of a second type of frog, *Platypelis*, and the recovery of a single bone of a medium-sized lemur, cf. *Hapalemur*. By number and biomass rodents made up 63% & 47%, frogs and lizards 23% & 7%, birds 6% & 12%, and lemurs 6% & 33% respectively.

DISCUSSION

Beza Mahafaly

Ptychadena mascareniensis, a marsh-dwelling frog active by day and night, is known to aestivate during the dry season, thus their appearance in the November 1990 sample presumably indicates that some rain had recently fallen. The absence of frogs in the other two samples coincided with the dry season at Beza Mahafaly. *Paroedura bastardi* is a nocturnal, partly arboreal lizard. Reptiles and amphibians make up a small portion of the diet of this owl at Beza Mahafaly.

The two bird species, *Hypsipetes madagascariensis* and *Foudia madagascariensis*, identified from the Beza Mahafaly material are diurnal and known to occur in the reserve (Nicoll & Langrand 1989). These two species are the most common birds at Beza Mahafaly; however, they constitute a small part of this owl's diet.

Two species of terrestrial insectivores were found in the Beza Mahafaly pellets. *Suncus murinus* was introduced to Madagascar in the early 19th-century (Hutterer & Trainer 1990). *Geogale aurita*, a member of the endemic family Tenrecidae, is common in the reserve (Nicoll & Langrand 1989). At least nine individuals of a bat, *Tadarida jugularis*, were identified in the June sample. Considerable numbers of this bat occupy day roosts from which they exit en masse at dusk.

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The lemur, *Microcebus murinus*, is common in the region. During the dry austral winter there is a reduction in overall activity of *M. murinus*, but at least in the dry deciduous forest along the west coast near Morondava it does not hibernate (Hladik *et al.* 1980). There is a distinct seasonal shift in the number of *Microcebus* taken by this owl: the biomass for the November sample was about 8% of the total, the March-April sample about 25%, and June sample over 40%. *M. murinus* reaches sexual maturity between the age of 8 to 12 months, the breeding season is between September and March, the average gestation period is 63 days, and the weaning stage is reached 40 days after birth (Martin 1972; Petter *et al.* 1977; Tattersall 1982). Thus, the highest densities of *Microcebus* moving about the environment would occur between early January and mid-June, which coincides with the seasonal increase in the number of lemurs taken by this owl.

The two species of rodents recovered from the Beza Mahafaly pellet remains, *Rattus rattus* and *Mus musculus*, are not native to the island and are generally human commensals. *Rattus* makes up approximately 50% of the total number of animals and 72% of the total biomass consumed by this owl. No native rodents have been recorded within the reserve (Richard *et al.* 1987; Nicoll & Langrand 1989); although *Eliurus m. myoxinus* and *Macrotarsomys bastardi* are known from the region (Carleton & Schmidt 1990).

Bezavona Forest

Both frog species taken at Bezavona Forest by the owl, *Boophis madagascariensis* and *Platypelis grandis*, are nocturnal and rain forest specialists. *Ptychadena mascareniensis*, the only frog species recorded from the owl food remains at Beza Mahafaly, is extremely common in the immediate area outside the Bezavona Forest. Thus at the latter locality, this owl does not appear to hunt frogs outside native rain forest. The presence of *Uroplatus* leaf-tailed geckos in the food remains is interesting, since they do not appear to be common in the area. During a herpetological survey of the Bezavona Forest in December 1989, including 25 hours of nocturnal hunting, just two individuals were noted of this poorly-known group of endemic nocturnal geckos. In the combined samples of pellets a MNI of seven *Uroplatus* were identified, or about 13% of the total animals found in these remains. When amphibians and reptiles are combined, they comprise approximately 20% of the total individuals and 5,9% of the biomass of the animals found in the pellets.

Four different birds were identified from the owl pellets, all of which occur within or at the edge of the Bezavona Forest. Each of the four species is represented by a single individual, and thus it would appear that this owl is not specializing on any bird species. Only one of the four species is nocturnal, a small owl (*Otus rutilus*). The birds fed upon by *Asio madagascariensis* are relatively large, varying in mean mass from 44,9 to 215 g. The three diurnal species (*Centropus*, *Eurystomus*, and *Hypsipetes*) may roost during the night in exposed places, such as the crowns of trees, and thus be easily taken by this owl. The stationary position of roosting birds may reduce potential difficulty that the owl may experience in subduing relatively heavy birds (e.g. *Centropus* and *Eurystomus*).

One skull and wing bones of a relatively large forest-dwelling bat, *Hipposideros commersoni*, was identified from the pellets. This nocturnal species is known to inhabit lowland closed canopy moist forests of southeastern Madagascar. It spends considerable portions of its foraging time hanging from a feeding perch (Vaughan 1977), and consequently would be vulnerable to owl predation.

Two species of lemurs were identified from the pellet remains. The identification of the cf. *Hapalemur* calcaneus has been discussed above. Martin (1973) found *Microcebus rufus* occurring in lowland montane forest in the general vicinity of the Bezavona Forest and *Microcebus murinus* in the littoral forest a few km away. Thus, we presume that the *Microcebus* bones recovered from the owl pellets are of *rufus*, but the possibility that some are *murinus* cannot be eliminated. At the Bezavona Forest, *Microcebus* seems to comprise a regular but relatively small portion of the diet of this owl, 7,2% by total number of individuals and 4,4% by biomass; at Beza Mahafaly the average for both total number of individuals and biomass is about 20%.

Four different species of rodents were identified from the pellet remains, two of which are native (*Eliurus myoxinus webbi*, *E. minor*) and two introduced (*Rattus*, *Mus*). The two *Eliurus* spp. are typical inhabitants of humid forest of Eastern Madagascar between sea-level and about 1600 m (Carleton & Schmidt 1990). *Rattus* and *Mus* are generally human commensals, although the former can often be found deep in the forest, particularly along river drainages, and not associated with any nearby human activity. The two introduced rodents make up a significant portion of the total number of animals and biomass of the diet of this owl species in the Bezavona Forest.

General

The greatest portion of this endemic owl's diet is introduced rodents. At Beza Mahafaly *Rattus* makes up 48,7% of the total individuals and 72,1% of the biomass and in the Bezavona Forest 38,2% and 40,8% respectively. During the colonization of the island by *Rattus* it is not known if this animal filled niches not occupied by indigenous rodents or displaced them. No native rodent was identified from the Beza Mahafaly material, while at the Bezavona Forest *Eliurus* spp. made up 20% of the total individuals and 15,3% of the biomass. It may well be that as *Rattus* colonized new areas of the island, presumably in the wake of new human settlements and forest fragmentation, *A. madagascariensis* was able to expand its range. An alternative explanation would be that the owl's distribution has not changed, but that as *Rattus* moved into new areas

the owl shifted its diet to include a greater portion of introduced rodents. If this latter scenario was indeed the case, the question then becomes what did this owl formerly eat - a greater proportion of native rodents and/or *Microcebus*? *Asio madagascariensis* occurs in Tsimbazaza Park, a 17 ha garden with exotic and native trees located in the capital city of Antananarivo, and its diet here must be largely composed of non-native mammals. Thus, this owl appears to show little habitat specificity.

All of the pellet remains reported herein were collected below known roosts of *Asio madagascariensis*. At the Bezavona Forest site the roost appeared to be occupied by a single pair of owls. We have no information on the daily movements of this owl within the area, and it is unknown if a single pair tends to roost at the same place each day. Thus, it is unknown what proportion of the total diet is represented by the pellet remains recovered below the roost, or the total intake of prey per unit time. The largest prey identified for *A. madagascariensis* is *Hapalemur* or *Avahi*, adults of which weigh between 740-1200 g. As we have no reason to suspect that this lemur was scavenged, it appears that *A. madagascariensis* is able to subdue prey at least twice its own weight.

Both localities studied are inhabited by a variety of raptors. At Beza Mahafaly, *A. madagascariensis* is sympatric with seven species of resident diurnal hawks, three species of nocturnal owls, and one species of diurnal boreal winter migrant (Langrand 1990; Goodman unpublished). Thus, at any time of the year at least 10 species of raptorial birds can be found in the area. At Bezavona Forest there are five species of resident diurnal hawks and two other species of nocturnal owls (Goodman unpublished). Further investigation is needed at these two sites of the interactions between a relatively large sympatric community of predators and their prey. A quantity of *Tyto alba* pellets from Beza Mahafaly is currently being studied (Goodman *et al.* in press). There is considerable overlap in the species of prey taken by *Tyto alba* and *Asio madagascariensis*, for example *Microcebus*.

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REVIEW

PORTER, D. J., CRAVEN, H. S., JOHNSON, D. N. & PORTER, M. J.(Eds). 1992. **Proceedings of the First Southern African Crane Conference**. Durban: Southern African Crane Foundation. 155 pp.

From 9–10 December 1989 about 70 delegates gathered at Rawdon's Hotel in the Natal Midlands for a memorable conference at which the Southern African Crane Foundation (SACF) launched its flagship in the form of these *Proceedings*. The conference has been referred to as "a conservation milestone" and this A5-sized package is an important publication.

The *Proceedings* are introduced by a statement from Don Porter, the Chairman of the SACF and Convener of this, its first, Conference. Twelve papers are then followed by summaries of the various discussion groups, a list of delegates and an Addendum including a management plan for conservaton of the Wattled Crane in South Africa (Tarboton & Johnson), the Southern African Crane census, 1985/1986 (Filmer & Holtshausen), Notes on cranes in Zimbabwe (Mundy) and Wattled Cranes on the Marromeu Floodplain [Mozambique] (Goodman).

Numbers of Crowned Cranes do not seem to have declined in the Transvaal in recent years (Tarboton), but the status of all three southern African species in Natal has worsened (Johnson): the plight of the Blue Crane in Natal is especially serious, its population having been reduced from over 1 000 birds in 1982 to just over 100 birds in 1989. Main causes of this depletion are loss of grasslands to timber farming, and the use of agricultural poisons.

Allan's paper on the Blue Crane in the Karoo and southwestern Cape, however, shows that Karoo populations are more or less stable, while those in the southwestern Cape have increased dramatically as more fynbos is converted to wheatland. In the eastern Cape all three crane species have suffered reductions, mainly as a result of farming activities (Vernon, Boshoff & Stretton). Stretton's subsequent paper confirms this, pointing to veld management, human persecution and environmental degradation as the main causes of the decline of Blue Cranes in the eastern Cape.

Data for the whole of South Africa, extracted from the Southern African Bird Atlas Project (SABAP) database, show little overall change in distribution, but point clearly to farming and other human disturbance as factors negatively affecting the Blue Crane in South Africa's grasslands.

Since cranes are largely or partly dependent on wetlands, the contribution by Begg on wetland conservation is of special significance: the wetlands of South Africa suffer from a "continually declining status", mainly because of sociopolitical obstructions to the implementation of conservation measures. Unless a holistic approach to the use of resources in South Africa is employed, the cranes, the wetlands and the people will continue to be increasingly deprived. A further conservation issue — "forestry" — is addressed by Tarlton who attempts to show that commercial growers of timber have conservation issues at heart (then why does the public continue to see increasing invasion of crane habitats by these same commercial growers?).

The recurring theme of human disturbance and modification of habitats is highlighted and discussed at length in the workshops scheduled towards the end of the Conference. These resulted in a Crane Conservation Action plan for Southern Africa, undoubtedly the most important outcome of the gathering and the most significant end-product in the *Proceedings*. The editors of the *Proceedings* are to be commended on this publication, despite its somewhat belated appearance. Southern Africa should pay good heed to the messages contained therein, not only for the conservation of cranes, but for the very survival of Africa.

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