PLAINS GERBILS (*GERBILLISCUS ROBUSTA*) AS FOOD OF THE BARN OWL (*TYTO ALBA*) IN THE SERENGETI PLAINS (TANZANIA): THIRTY-SIX YEARS LATER

RBM Senzota
Department of Zoology and Wildlife Conservation, University of Dar es Salaam,
PO Box 35064, Dar es Salaam, Tanzania, Email: senzota@udsm.ac.tz

ABSTRACT

*The barn owl (*Tyto alba *(Blyth 1862) roosts and nests in crevices and caves of kopjes (rock outcrops) of the Serengeti plains. Its major food in the 1970's was found to be* Gerbilliscus robusta *(Cretschmer 1826) which inhabits the expansive grasslands surrounding the kopjes. In October 2012, pellets of the owl were collected from one of its roosting cave in the Gol Kopjes at the plains; the roosting cave was the same as one where a 1976 pellet collection was made. Collected intact and disintegrated pellets were weighed and sorted to identify and enumerate their contents. Morphometrics of sorted out bony remains from the pellets were measured to assist in identifying the taxonomic status of the pellet contents and in determining the size ranges (including lengths and widths) of bone pieces ingested by the owls. Pellet contents of the 2012 collection were found to be of similar sizes and types as those of 1976 suggesting that species composition of the pellet contents was similar over the 36 year period. Skull and other bone contents were mostly (about 90%) of* Gerbilliscus robusta*, suggesting this rodent to still be an important food item of the barn owl in the Serengeti short grassland plains.*

Key words: Serengeti plains, kopjes, Barn Owl, plains gerbil

INTRODUCTION

The short grassland plains in the southeast of the Serengeti Ecosystem are an important component of this globally unique ecosystem (Marttila 2011). It is on these plains that the great migrating populations of ungulates undertake annual parturition and obtain their most nutritious annual forage; in turn, the mammals influence structure of the grasslands (Bell 1971, Maddock 1979, McNaughton 1990, Augustine *et al*. 2003). Still there are other animals of the plains that, though largely inconspicuous, might be adding to the shaping of the plains in a number of ways. Among them are the plains gerbils (*Gerbilliscus robusta* (formally *Tatera robusta* (Senzota 1983a, 1984, Kingdon 1974, Senzota *et al.* 2012) and the Barn Owl (*Tyto alba*). Their biology and ecology on the plains have received but few studies (Senzota 1990, Reed 2011).

Gerbils are ground dwelling rodents that have also been tamed as pets (Fox 2011). Simultaneously, gerbils have also acted as pests when inhabiting areas close to farming communities. They contribute significantly to the food of a number of small predators and raptors (Kingdon 1974, Agren 1985). They construct tunnels and nests underground and in so doing bring up large amounts of soil that may cover grass and thus denude the affected land. Through their burrowing activities they also mix and aerate soil (Senzota 1984). This study examines the presence of the gerbils in the food of Barn Owls in two periods that are 36 years apart as a way of seing if their role as food to the owls has changed over this span of period. In 1974, flooding from a rainfall killed many gerbils (Fig. 1); heavy rains also occurred during an El Niño event in 1997/1998 (Ogutu *et al*. 2007). This event might have affected gerbil populations and could be reflected as reduced gerbil component in the food of the Barn Owls. Barn Owls feed on the animals they kill themselves, mostly rodents, by tearing and swallowing their prey (Anon 2012). Un-digestible material (such as bones, hair and feathers) is compressed into oval-shaped pellets and regurgitated. Analysis of the pellet contents thus enables detection of the types of food they eat. Basic data on limb lengths will make it easier to derive comparisons in future studies, both for species identification and on variations in the sizes of animals that the owls will be feeding on. Limb and skull characteristics are important standard morphometrics used in the identification of rodent specimens.

Figure 1: Drowned plains gerbils following heavy rains on the Serengeti plains, Tanzania, in 1974. (Photo courtesy of Dirk Kreulen).

METHODS

Intact and disintegrated pellets of *Tyto alba* were collected, separated and the contents identified. Collections were made from the Gol kopjes on the Serengeti plains in 1976 – 1978 and 2012 (Fig 2, refer map (Fig. 1) in Timbuka and Kabigumila (2006)). Pellets were kept in tightly sealed plastic bags and subsequently weighed to determine their fresh and oven dry weights. Oven dry weights were taken after drying the samples for 62 hrs at 70°C. Disintegrated pellets were carefully sorted out for their contents such as rodent skulls, bird skulls, pieces of plants and other unidentified material which were then counted and lengths of intact skulls and parts of limbs measured in centimeters. Intact pellets were each measured for length and width (cm) and subsequently disintegrated and parts sorted out for specific contents of hair, parts of limbs, skulls and jaws to identify their taxa. Lengths of parts of limbs were measured (cm) and within pellet Coefficients of Variation (CV) determined. For intact pellets and bird skulls, a relationship was worked out between their lengths and widths. Comparisons were made for differences between pellets in lengths of limb parts. Statistical treatments followed the InStat Graph Pad Software (http://www.graphpad.com/instat/instat.htm) (site visited on 20th August 2012). Where unspecified, cut-off level for significance was 0.05. CV values were expressed as percentage Standard Deviations (SD) divided by the mean (100SD/mean).

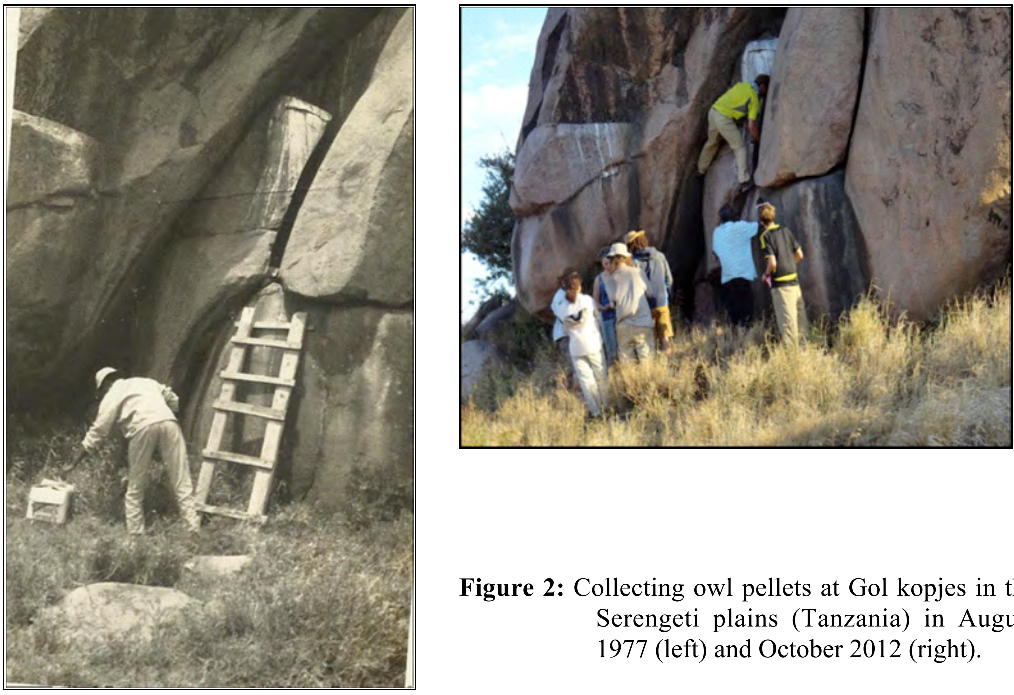

Figure 2: Collecting owl pellets at Gol kopjes in the Serengeti plains (Tanzania) in August 1977 (left) and October 2012 (right).

RESULTS

Two hundred and fifty five grammes (255 g) of owl food remains were collected during the October 2012 field study. In the cause of handling the collected material, some fine-grained parts were accidentally lost thus resulting in only 245 g in the total of different components indicated in table 1. The collected sample had a total of 21 pellets, 13 intact pellets, rodent skulls, bird skulls, many pieces of rodent bones, pieces of plant remains and other loosely held material including hair, feather and insect cuticle (Table 1; Fig. 3). Further analysis is required, but about 90% of the skull and jaw remains in the 2012 collection were estimated to be of *Gerbilliscus robusta*. Intact pellets had a mean length of 4.3 ± 1.14 cm (SD) and a mean width of 2.9 ± 0.54 cm. Pellets length was significantly larger than width ($t_{17} = 6.178$, $P < 0.0001$); the relationship between their paired readings was insignificant ($r^2_{17} = 0.177$, $P > 0.05$) suggesting that pellet length could not predict pellet width. Lengths and respective widths of bird skulls were significantly related ($r^2 = 0.628$, $F_{1,5} = 8.441$, $P < 0.034$, Table 2). Both disintegrated material and intact pellets contained varying quantities of food remains (Tables 2 - 4; Fig. 3).

Table 1: Number and weight (g) of different constituents of discarded food material from the owl roost site at Gol Kopjes, Serengeti plains, Tanzania. October 2012. – not determined

	Total pellets	Rodent Skulls	Bird skulls	Pieces of limbs	Plant material	Other particles
Number	21	2	6	118	9	-
Fresh weight	120	10	10	15	5	85
Dry weight	80	8	-	13	-	60

Table 2: Lengths and widths (cm) of ingested pieces from disintegrated pellets collected from the owl roost site at Gol Kopjes on the Eastern Serengeti plains, Tanzania. October 2012.

	Mean	n	SD	% CV	Med	Min	Max
Rodent bones	2.1	109	0.71	33.8	2.0	1.0	3.5
Bird skull length	1.4	7	0.32	22.9	1.4	1.0	2.0
Bird skull width	0.8	7	0.20	25	0.8	0.6	1.0
Length of plant pieces	5.5	8	3.59	65.3	5.3	1.8	12.6

Table 3: Number of pieces of different parts of rodent bones, insects and other unidentified material in intact pellets of owl pellets collected from the Serengeti plains (Tanzania) in October 2012.

	Mean	n	SD	% CV	Med	Min	Max
Ribs	27.9	12	20.60	73.8	22	4	66
Vertebrae	5.6	12	6.16	110	2.5	0	18
Skull and jaws	13.6	12	9.26	68.1	10	0	29
Limb	34.0	12	22.58	66.4	32.5	1	76
Scapula	5.8	12	3.84	66.2	5	2	15
Insects	1	12	2.38	238	0	0	7
Others	9.8	12	7.47	45.6	7.5	0	25

Table 4: Lengths (cm) and related parameter of scapula from intact pellets collected from Serengeti plains (Tanzania) in October 2012.

	Mean	n	SD	% CV	Med	Min	Max
Pellet 1	1.4	5	0.06	4.3	1.4	1.4	1.5
Pellet 3	1.4	9	0.17	12.1	1.4	1.1	1.6
Pellet 4	1.5	5	0.19	12.7	1.5	1.2	1.7
Pellet 5	1.4	12	0.34	24.3	1.5	0.7	1.8
Pellet 8	1.4	7	0.26	18.6	1.4	1.0	1.7
Pellet 11	1.3	4	0.05	3.9	1.3	1.2	1.3

FIG. 3A: OVERALL CONTENTS

Figure 3 a&b: Overall contents of owl food remains from a roosting site in the Serengeti short grassland plains, Tanzania. October 2012.

Lengths of limb parts varied significantly between pellets (Table 5; Fig 3; Corrected Bartlett statistic = 127.36, $P < 0.0001$; Kruskal – Wallis Statistic = 77.402, P (χ^2 approximation) < 0.0001). Significant ($P < 0.05$) differences were observed between pellet 2 with pellets 7 – 12 and pellet 6 with pellets 3, 5, 7 – 9 and 12. Overall, contents were predominantly (≈ 90%) parts of *Gerbillus robusta* (Figs. 3&4; sensu Stanley

2001, Wilson and Reader 2005, Senzota 1983a). The hair was soft, incisors were grooved and yellow in colour, lophs on molars and premolars were typical of *Gerbilliscus robusta* (Fig. 3).

Table 5: Lengths (cm) and their related parameters of parts of limbs from intact owl pellets collected from eastern Serengeti plains (Tanzania) in October 2012.

	Mean	n	SD	% CV	Med	Min	Max
Pellet 1	1.1	46	0.27	24.6	1.1	0.6	2
Pellet 2	1.9	25	0.68	35.8	1.5	1	3.3
Pellet 3	1.0	57	0.26	26	1	0.5	1.5
Pellet 4	1.0	55	0.37	37	1	0.4	1.9
Pellet 5	1.0	54	0.27	27	1	0.5	1.6
Pellet 6	1.4	15	0.40	28.6	1.4	0.7	2.1
Pellet 7	0.9	42	0.63	70	1.0	2	2.9
Pellet 8	0.9	38	0.31	34.4	0.9	0.3	1.3
Pellet 9	1.0	28	0.76	76	0.6	0.3	2.7
Pellet 10	1.1	11	0.56	50.9	0.9	0.4	2.2
Pellet 11	1.1	20	0.30	27.3	1.2	0.5	1.6
Pellet 12	0.9	22	0.29	32.2	1.0	0.3	1.4

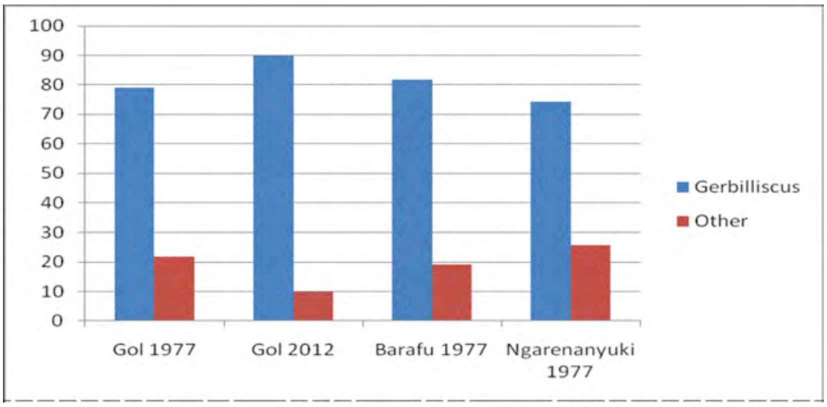

Figure 4: Percent composition of *Gerbilliscus robusta* remains in pellets of *Tyto alba* at Gol and the other kopjes in the Serengeti plains, Tanzania, in 1977 and 2012.

In the collection of the 1970's, % composition of *Gerbilliscus robusta* remains in the owl pellets increased as one moved from the edge of the woodlands in the west to the treeless grasslands in the east viz: 74% at Ngarenanyuki kopjes, 79% at Gol Kopjes and 82% at Barafu kopjes (Senzota 1990). This suggested that *G. robusta* contributed a bigger portion of the Barn Owl food in the more open areas (Figure 4).

DISCUSSION

Barn owls are widespread in East Africa preferring forest edges and woodlands where they can use trees for roosting; they tend to avoid arid areas (Stevenson and Fanshawe 2002). Their occurrence on the short grassland plains in eastern Serengeti thus owes much to the presence of the rock outcrops there which harbor a unique biota in relation to the surrounding grasslands (Gerlach and Hoeck 2001, Trager and Mistry 2003, Poelchau and Mistry 2006, Timbuka and Kabigumila 2006). Typically the Serengeti plains receive a mean wet-season rainfall of only about 500 mm (Sinclair 1979) and thus falls within the semi-arid to arid eco-climatic zone of East Africa (sensu Pratt and Gwynne 1978) that would not be a preferred habitat of Barn Owls. However, owls are also reported to be more successful at hunting and capturing gerbils in areas of low cover (Laurie 1971, Senzota 1990, Kotler *et al.* 1991, 1992, Anon 2012). Without the kopjes, the Serengeti plains would restrict occurrence of owls since the plains lack trees that would afford roosting sites of the birds. Gerbils are known to be a main food of the owls and are abundant on the short grasslands of the eastern Serengeti plains. Serengeti plains have soft volcanic soils that allow easy burrowing by these rodents which live strictly underground coming out only at night to forage (Senzota 1983a, 1986, Reed 2011). This way, the expansive grasslands and their rock outcrops together provide a habitat that allows coexistence of these two species which are important for conservation, tourism and education. Barn Owls are interesting birds that have occasionally been described as 'ghostly' (Stevenson and Fanshawe 2002). Owls are also positively considered for rodent pest control as biological control agents that avoid the use of environmentally hazardous rodenticides (Thomas *et al.* 1990, Hofffman 1999, Vazzana 2010, Anon 2012). *Gerbilliscus robusta* also harbors a number of ectoparasites, some of which might infest the other sympatric mammals on the plains (Senzota 1992). It is recommended to continue seeking more basic data on the biology and ecology of the gerbils that predominate the expansive Serengeti plains as well as the biology, ecology and monitoring of their owl predators which appear to have their population size in the plains influenced by presence of the rather few rock outcrops. Barn Owls in the Serengeti plains use kopjes for roosting and nesting; they thus are part of the unique biota that is characteristic to the Serengeti kopjes (Trager and Mistry 2003, Poelchau and Mistry 2006). Besides the three rock outcrops (Barafu kopjes, Gol kopjes and Maasai kopjes), the short grasslands of Serengeti plains have few other suitable roosting and nesting sites for the Barn Owls (Senzota 1990, Reed 2003).

Compared to the larger mammals, few studies have been conducted on the gerbils of the Serengeti plains. Their roles in soil mixing and aeration, consumption of the primary production, maintenance of predator and raptor populations and parasite and disease reservation need further detailed studies (Senzota 1984, 1992). Would their feeding specialization on grass seeds facilitate resource partitioning among the grass eating mammals as has been suggested for grass rats in other parts of the ecosystem? (Sinclair 1975, Senzota 1983b, 1986). Did they play a role in the evolution of early hominoids as vermin, disease causative agents or source of protein? "As paleoenvironmental indicators, micromammals provide a signal of local paleoenvironments at a smaller spatial grain than large mammals and thus may prove critical to resolving some of the ambiguities of paleoenvironmental interpretations at Laetoli"(Reed 2011). In 1974 a gerbil die-off occurred on the plains following drowning from a heavy rainfall (Senzota 1984; Fig 1).What can be the predictions on their populations in the context of the impending global environmental perturbations? As indicated above (results), observations of the present (1976/78 and 2012) collections showed the owl pellets to constitute mainly (about 80) *G. robusta*. Details on the morphometrics of components in the collected samples and their use in identification of species of animals eaten by the Barn Owl will be published elsewhere.

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