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Understanding sitatunga (*Tragelaphus spekii*) habitats through diet analysis in Rushebeya-Kanyabaha wetland, Uganda

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Abstract

Between January and December 2008, we assessed the diet and habitat selection of sitatunga, a highly endangered tropical wetland antelope threatened by habitat loss in Rushebeya-Kanyabaha wetland. Microhistological faecal analysis and vegetative sampling methods were used to assess plant forms, species and seasonal changes in the sitatunga diet. Habitat use was indirectly determined by assessing feeding patterns, distribution of dung and trails within the wetland. Sitatunga fed mainly on herbs, sedges, grasses and shrubs. A total of 34 plant species were recorded as eaten by sitatunga. The most eaten plant species was *Cyperus papyrus* L. (22%). *Malenthera scandens* Schum. & Thonn., *Polygonum senegalense* Meisu (12%) and *Polygonum pulchrum* Blume (5%) were the most eaten herbs. *Zea mays* L. was the most eaten agricultural crop (58% of domestic crops), mainly during the wet season. Sitatunga feeding was mainly concentrated on the wetland edge habitat (46%) where most of its food (53%) was located. The other preferred habitat was the tall closed papyrus. We conclude that the long-term survival of sitatunga requires a management plan focussing on the conservation of the most preferred plant species and habitats.

Key words: microhistological, Rushebeya-Kanyabaha, *Tragelaphus spekei*, tropical wetland

Résumé

Entre janvier et décembre 2008, nous avons évalué le régime alimentaire et la sélection de l'habitat du sitatunga, une antilope de zones humides tropicales, extrêmement menacée par la perte de son habitat dans la zone humide de Rushebeya-Kanyabaha. Nous avons utilisé une analyse micro-histologique des excréments et des méthodes d'échantillonnage de la végétation pour évaluer les formes et les espèces végétales et les changements saisonniers du régime des sitatungas. La fréquentation de l'habitat fut déterminée indirectement en évaluant les schémas d'alimentation, la distribution des crottes et les pistes dans la zone humide. Les sitatungas se nourrissent principalement d'herbes dicotylédones, de laîches, de graminées et d' arbustes. On a enregistré un total de 34 espèces végétales consommées par le sitatunga. L'espèce la plus consommée était *Cyperus papyrus* L. (22%). *Malenthera scandens* Schum. & Thonn., *Polygonum senegalense* Meisu (12%) et *Polygonum pulchrum* Blume (5%) étaient les herbes dicotylédones les plus consommées. *Zea mays* L. était la plante cultivée la plus consommée (58% des cultures domestiques), surtout pendant la saison des pluies. Les sitatungas se nourrissaient principalement en lisière de l'habitat humide (46%) où ils trouvaient la plus grande partie de leurs aliments (53%). L'autre habitat de prédilection était les étendues fermées de grands papyrus. Nous en concluons que la survie à long terme du sitatunga exige un plan de gestion centré sur la conservation des espèces végétales et des habitats qu'il préfère.

Introduction

The sitatunga (*Tragelaphus spekii*), a highly restricted semi-aquatic tropical antelope, inhabits wetlands and associated ecosystems, but is currently endangered throughout its

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African range (IUCN/SSC Antelope Specialist Group, 2008). The major causes of threats are wetland reclamation, hunting and unsustainable harvesting of the plant species that constitute its food (IUCN, 2007). In addition, the species has low resilience to these threats (Ocen & Andama, 2002). This partly explains the species' declining populations (IUCN/SSC Antelope Specialist Group, 2008) and local extinctions as in Niger, Togo and some parts of East Africa (Tweheyo, Amanya & Turyahabwe, 2010). Other aspects of sitatunga ecology like breeding and behaviour have received considerable attention in scientific literature (e.g. Kingdon, 1982; Magliocca, Quérouil & Gautier-Hion, 2002), but information on its diet and habitat use remains limited. Here, we examine sitatunga habitat selection and diet as important aspects that determine their survival in the present habitats.

This study, therefore, documented plant species and forms eaten by the sitatunga; assessed the agricultural crops included in sitatunga diet; assessed the distribution, abundance and diversity of plant species eaten by the sitatunga in a Ugandan wetland. We also determined the habitat types where sitatunga food is located and assessed seasonal differences in sitatunga diet and habitat availability. The study has enriched the present knowledge regarding diet and habitat preference of sitatunga. Information on diet, habitat selection and patterns of movement of the sitatunga will guide future conservation measures for both the sitatunga and other wetland resources. In particular, this study is useful to wildlife managers and conservationists in tropical regions.

Methods

Study area

Rushebeya-Kanyabaha wetland is located in Kabale district, south-western Uganda, between 29°59′–30°07′E and 1°03′–1° 09′ S, at an average altitude of 1735 m (MWLE & KDLG, 2001); and the wetland is about 15 sqkm (NEMA, 1997). Over 85% of the wetlands in the district were converted to crop and diary farming, and this is the largest remaining wetlands in the district. It is the only remaining intact wetland at such an altitude in Uganda. The climate is tropical with mean annual rainfall of 800–1000 mm (NEMA, 1997) and a bimodal rainfall pattern with peaks from March to May and September to November.

The wetland has a mosaic of natural vegetation, open water patches and agricultural crop fields on its fringes. The dominant natural plant species in the wetland include *C. papyrus* L., *Cladium mariscus* L. and *Cyperus dives* Del. with patches of *Miscanthidium violaceum* scattered among these. The wetland edges and degraded patches are dominated by herbaceous plants notably *Polygonum senegalense* Meisu. The wetland is rich in birds with globally threatened species such as Papyrus Yellow Warbler (*Chloropeto graciliroshtris*), papyrus gonolek as well as Uganda's national bird, the crested crane (*Balearica regulorum gibbericeps)*. The wetland is also home for the IUCN red data–listed Congo clawless otter (*Aonyx congica*) and is also rich in fish such as *Clarias* spp. and *Protopterus* spp. With almost all the available arable land in this region already used, the wetland is locally viewed as the only potential source of land for agricultural expansion.

Data collection

As the sitatunga is a shy animal (Owen, 1970), we used indirect sampling methods involving field diet sampling and microhistological faecal analysis to assess its diet and habitats; and a total of 1760 h were spent in the field.

Faecal counts and path enumeration

Following the faecal count method (Steinheim *et al.*, 2005), a total of 60 transects running north–south at intervals of 250 m were established to cover the 15 km stretch of the wetland. Along the transects, fresh sitatunga dung piles were enumerated within a radius of 5 m from points established every 100 m. For each dung pile, the corresponding vegetation and habitat type were recorded and plant specimens collected. About 200 g of dung per sample was collected in polythene bags for later use in microhistological faecal analysis. We also enumerated sitatunga paths along transects. Sitatunga paths and dung were easily traced because sitatunga follows regular established paths within the wetland.

Identification and recording of feeding signs

Following Ocen & Andama (2002), sitatunga feeding signs were used to identify the most used habitats and most frequently grazed plants. The sitatunga feeding signs could not be confused with those of other animals because sitatunga are the only known wild ungulates in the study site, and the feeding signs of domestic ungulates are known to the local field assistants who were part of our research team. The data from feeding signs supplemented data from microhistological faecal analyses.

Site stratification

To classify the different habitats where sitatunga food is located, the wetland was stratified into nine types based on physiognomic features and dominant plant species as follows: tall closed papyrus (TCP), light open papyrus (LOP), open grassland (OG), wetland edge (WE), marshy/boggy habitat (MBH), tall closed sedges (TCS), light open sedges (LOS), open water (OW) and burnt/regenerating habitats (BRT). The plant forms in the wetland were categorized as follows: herb (HB), climber (CL), tree (T), shrub (S), grass (G) and sedge (SED).

Microhistological faecal analyses

We used microhistological faecal analysis, a method of diet analysis, that quantifies the botanical compositions of animal diet by identifying plants from epidermal characteristics of ingested species (Sparks & Malechek, 1968). The method has been widely used in studies to determine botanical composition of diets of range herbivores (e.g. Chapuis *et al.*, 2001; Wegge, Shrestha & Moe, 2006) and is suitable for studying secretive and rare animals because faecal samples can be obtained without intensive animal observation.

Specimens of all plant species, which appeared to be eaten by the sitatunga from the feeding signs observations, were collected in duplicates from the different habitats in the wetland, as well as cultivated crops on the wetland periphery. One of the duplicate samples was sun-dried and used for the preparation of reference slides. The other duplicate sample was pressed and taken to Makerere University Herbarium for identification purposes. The leaves of the collected samples were initially sun-dried and then oven-dried at 60–70°C to ensure that they were easy to crush. The dry leaves were shredded coarsely using an electric grinder and sieved through a 1-mm screen followed by a 210-μm Endicott sieve to obtain a homogenous size of fragments and remove dust as well as fine unidentifiable particles. In this way, reference material simulated the small fragments found in the faecal samples. A teaspoonful (1–5 g) of the ground material was put into a test tube and mixed with 10 ml of 3.5% sodium hypochlorite (household bleach) to clear the epidermal tissues of plant material. The contents of the test tube were kept standing on the shelves for 24 h, and later the dark supernatant liquid was decanted, replaced with fresh sodium hypochlorite and allowed to settle for 6 h. This was repeated 2–3 times at shorter time intervals until a clear solution was produced. The residue was washed with freshwater followed by absolute alcohol to eliminate the excess sodium hypochlorite. The reference material was then dehydrated through a series of alcohol and xylene (75%, 50%, 25%) mixtures following Anthony & Smith (1974). A small quantity of the dehydrated material was then uniformly mounted in D.P.X. microscopic mountant under a 24×50 mm cover slip. The prepared plant material slides were then dried in air for 5–7 days before examination.

Detailed drawings of species-specific cell characteristics of the reference plants were made in ordinary pencil with a free hand, and photomicrographs of the plant epidermal cells were also taken using a microscope (Carl Zeiss) fixed with a camera following the procedures of Johnson, Wofford & Pearson (1983) and Marrero and Nogales (Marrero & Nogales, 2005). The individual species were classified as grasses, sedges, forbs (broad-leaved herbaceous plants) and browse (all woody plants). Species that could not be identified as species or genus were categorized as unidentified grasses, sedges, forbs or browse. Those that could not be assigned to any growth form were categorized as 'unknown'. The fragment drawings and photomicrographs were later used to characterize and identify the plant species found in the faecal material.

In addition to the reference material, thirty fresh sitatunga faecal samples were also collected during the dry season. During the wet seasons, it was difficult to collect faecal samples as the rain easily destroyed them. Prior to sample collection, the fresh dung was thoroughly mixed and a portion (200 g) was extracted for further processing. The collected faecal samples were temporarily preserved in 5% formalin solution. Sitatunga dung was identified from dung of other species by drawing from the experience of the local field assistants and assessing the evidence of its foot prints, trails and feeding signs in the vicinity.

The preparation of the faecal samples followed the same protocol used for preparing the reference material after which fragments in the dung samples were identified by comparison with fragments and drawings made from the reference slides. Identification was based on epidermal characteristics (Davis, 2003; Johnson, Wofford & Pearson, 1983; Sparks & Malechek, 1968). The microanatomical structural components used for identification included the following: (i) cutinized epithelial cells; (ii) type of venation; (iii) cell wall (shape, thickness and contour); (iv) trichomes/prickles (shape and frequency); (v) glands, stomata (size, shape, arrangement and density patterns); (vi) silica cells (presence or absence), crystals, subsidiary cells and epidermal cells following Johnson, Wofford & Pearson (1983) and Marrero & Nogales (2005).

For purposes of quantification of plant fragments, the proportions of diet components were estimated using the number of fragments of each forage class relative to the total number of fragments observed (Alipayo *et al.*, 1992; Johnson, Wofford & Pearson, 1983). Faecal samples were analysed using a binocular compound microscope at 200× magnification. Twenty fields were observed in each slide, and species were recorded as present or absent until a total of 100 frequency observations were recorded for each sample. Following Johnson, Wofford & Pearson (1983), the frequency was used to determine the percentage compositions by weight of each species as follows:

$F = 100$ (1-e-d), where F is relative frequency; e is the natural logarithm; and d is the mean particle density determined by the number of fragments (n) and the number of microscope fields examined (k) so that $d = n/k$. If fragments from m different plant species are randomly distributed in the microscope fields, the particle density of each is independent of the others. Thus, the density (d) of fragments per field may be converted to relative density (RD) as follows:

$$\mathrm{RD} = \frac{\text{Density of discerned fragments for an individual species} \times 100}{\text{Densities of discerned fragments for all species}}$$

Data analysis

Cross tabulation was carried out between different variables, such as habitat type, plant species, plant form and season. To determine whether there was a significant difference in choice of plant species eaten and whether the distribution patterns of eaten plant species in the habitat were significantly different, the Kruskal–Wallis test was used. This test was applied because the data were not normally distributed. A standardized Z-score in Minitab was used to rank plant forms eaten and the habitats used. A chi-squared test (χ^2) was used to test whether quantities of agricultural crops eaten by sitatunga were different from those of wetland species eaten. The same test was also used to test for significance in the distribution of sitatunga dung and paths within habitats to assess the occurrence of sitatunga. All statistics were performed at 95% CI.

Results

Plant species eaten by sitatunga

During vegetation sampling, a total of 2535 individual plants comprising 90 plant species in 43 families were recorded. Of the 90 species, 34 were eaten by the sitatunga (Table 1). Up to 70% of the species eaten belonged to the following families: Cyperaceae (25%), Asteraceae (12%), Poaceae (9%), Typhaceae (6%), Convolvulaceae (6%), Poligonaceae (6%) and Nymphaeceae (5%). In terms of species, *C. papyrus* and *C. dives* were the most eaten. Other species that contributed substantially to the sitatunga diet include *Malenthera scandens*, *Typha capensis*, *Ipomoea batatas*, *Nymphaea lotus*, *P. senegalense* Meisu and *Zea mays*. Of these, *I. batatas* and *Z. mays* are domestic crops.

Of the 34 species recorded as eaten during the vegetation sampling, 14 were confirmed by the microhistological faecal analysis, which revealed *C. papyrus* L. as the most eaten followed by *P. senegalense* Meisu, *T. capensis* Rohrb, *Polygonum pulchrum* Blume and *Z. mays* L. (Table 2). Domestic crops supplemented wetland species by 5% of the overall sitatunga diet, and there was a significant difference in the consumption of the four eaten agricultural crops ($F_{3,116} = 14$, $P \leq 0.05$; GLM ANOVA). *Zea mays* (maize) was the most frequently eaten crop followed by Finger millet (*Eleusine coracana*), beans (*Phaseolus vulgaris*) and sweet potatoes (*I. batatas*).

Plant forms and parts eaten by sitatunga

Vegetation sampling. Vegetation sampling showed that sitatunga fed mainly on herbaceous plants and sedges (Fig. 1a) followed by climbers and grasses. Water weeds, shrubs and trees were not major components of the diet.

Microhistological faecal analysis. Results from microhistological faecal analysis differed from vegetation sampling. There was a significant difference in the consumption of the four different plant forms, i.e. sedges, herbs, shrubs and

Table 1 Sitatunga diet based on vegetative sampling in Rushebeya-Kanyabaha wetland, south-western Uganda, January–December 2008

Species	Status	Life form	Percentage in diet
Cyperus papyrus L.	Wild	Sedge	11
Cyperus dives Del.	Wild	Sedge	10
Malenthera scandens (Schumach. & Thonn)	Wild	Herb	7
Typha capensis Rohrb.	Wild	Sedge	6
Zea mays L.	Domesticated	Grass	6
Nymphaea lotus L.	Wild	Herb	5
Mikania cordata (Burm. f.) B.L. Robinson	Wild	Herb	5
Polygonum senegalense Meisu	Wild	Herb	4
Ipomoea batatas (L.) Poir. & Lam.	Domesticated	Vines	4
Rubus pinnatus (*R. rigidus*) Sm.	Wild	Shrub	3
Digitaria scalarum Chiov.	Wild	Grass	3
Thelypteris confluens (Thunb.) C.V. Morton	Wild	Herb	3
Cladium mariscus L.	Wild	Sedge	3
Erlangea tomentosa S. Moore	Wild	Herb	3
Solanum tuberosum L.	Domesticated	Herb	3
Crassocephalum vitellinum S. Moore	Wild	Herb	2
Polygonum setosutum R. Br.	Wild	Herb	2
Commelina benghalensis L.	Wild	Herb	2
Ipomoea tenuirostris Choicy.	Wild	Herb	1
Jussiaea abyssinica (A. Rich.) Dandy & Brenan	Wild	Herb	1
Pennisetum purpureum Schum.	Wild	Grass	1
Crassocephalum montuosum (S. Moore) Milne-Redh.	Wild	Herb	1
Ageratum conyzoides L.	Wild	Herb	1
Myrica kandtiana Engl.	Wild	Herb	1
Eleusine carocana (L.) Gaertn.	Domesticated	Grass	1
Miscanthus violaceus K. Schum.	Wild	Grass	1
Achyranthes aspera L.	Wild	Herb	1
Brassica oleracea L.	Domesticated	Herb	1
Carex cognate Kunth *var. congolensis* (Turrill)	Wild	Sedge	1
Acalypha psilostachya Hochst	Wild	Herb	1
Plectranthus sp.	Wild	Herb	1

grasses ($H = 8.12$, df = 3, $P \leq 0.05$, Kruskal–Wallis test). Sedges and herbs formed the major part of the diet (Fig. 1b).

Considering the preference index of plant form counts, herbs and sedges were above the mean score (Fig. 2), implying that the sitatunga preferred herbs and sedges to the rest of the plant forms. Trees were the least preferred plant form. The range of preference was −1.5 to 2.

Distribution of sitatunga food plants in different habitats

Most plant species eaten by sitatunga occurred on the wetland edge (53%) followed by tall closed papyrus habitats (11%). The open water, the river boundary and open grassland had few (<3%) plant species eaten. *N. lotus* L. was the only water plant eaten by the sitatunga.

Variation of plant species richness with distance from wetland edge

The number of species eaten was significantly related to distance from the wetland edge ($F_{2,165} = 63$, $P \leq 0.001$). Most species (70%) were recorded within a distance of 20 m from the wetland edge towards the interior. The wetland edge was a mosaic of *C. papyrus* with herbaceous plants and grasses. Notable among these were *P. senegalense*, *P. pulchrum*, *Erlangea tomentosa*, *M. scandens* and grasses from family Poaceae. From about 20 m towards the interior, the number of herbs and grasses decreased drastically to give way to a mono-dominant *C. papyrus* habitat. Beyond 40 m, the papyrus merged into thorny sedges dominated by *C. mariscus* mixed with *T. capensis.*

Table 2 Sitatunga diet based on microhistological faecal analysis in Rushebeya-Kanyabaha wetland, south-western Uganda, January–December 2008

Scientific name	Local name	Life form	Percentage in diet
Cyperus papyrus L.	Ekitogo	Sedge	2
Polygonum senegalense Meisu.	Omuryanjobe	Herb	1
Typha capensis Rohrb	Omubimbiri	Sedge	1
N/A	Unknown forb	Herb	1
N/A	Unknown sedge	Sedge	1
N/A	Unknown grass	Grass	5
Polygonum pulchrum Blume	Omunkaranga	Herb	5
Zea mays L.	Obucoori	Grass	3
Cladium mariscus L.	Enchemba	Sedge	3
Digitaria scalarum Chiov.	Coach grass	Grass	2
Thelypteris confluens (Thunb.) C.V. Morton	Ekisiru	Herb	2
Cyperus dives Del.	Ekikangaga	Sedge	2
Eleusine carocana (L.) Gaertn.	Obulo	Grass	1
Jussiaea abyssinica (A. Rich.) Dandy & Brenan.	Enshagamanungi	Herb	1
Cynodon aethiopicus Clayton & Harlan	Kalandalugo	Grass	1
Pennisetum purpureum Schum.	Ekibingo	Grass	1
Carex cognate Kunth *var. congolensis* (Turrill)	Entaratara	Sedge	1
Phaseolus vulgaris L.	Ebihimba	Herb	1
Malenthera scandens Schum. & Thonn.	Ekarwe	Herb	1
Myrica kandtiana Engli.	Omugyegye	Shrub	1
	Others (assorted)		4

Variations in sitatunga diet, feeding and presence in habitats

Generally, wetland species contributed more to the sitatunga diet, particularly in the dry seasons (January, February, July and August). The importance of agricultural crops increased with precipitation reaching a maximum at the peak of the wet season (April–May and October–November) (Fig. 3). The distribution of dung and paths differed significantly between the three most preferred habitats (wetland edge, tall closed papyrus and light open papyrus) ($\chi^2 = 24$, df = 2, $P \leq 0.001$). Most dung piles were found in the wetland edge and light open papyrus habitats, and no dung was recorded in the tall closed sedges. No paths were recorded in the light open sedge habitat. Feeding was mainly recorded in the wetland edges followed by tall closed and light open papyrus. Analysis of feeding frequency by estimation of a preference index confirmed the wetland edge as the most preferred habitat (Fig. 4).

Discussion

Plant species and plant form eaten by the sitatunga

Consistent with earlier findings (e.g. Ocen & Andama, 2002; Starin, 2000), our study showed that the sitatunga feeds on a relatively large variety of plant species. However, this is contrary to some other findings (e.g. Games, 1983; Owen, 1970) that reported the sitatunga as a selective feeder. What is significant about this study is that the studied sitatunga is able to depend on a wide range of species and plant forms to survive in this restricted habitat. The animal has learnt to survive on fallback plant foods, and we have not come across any study that indicates such a wide range of dietary choice by the sitatunga. This study has, therefore, demonstrated that sitatunga can adapt to a wider range of foods when left in a restricted habitat.

The study confirmed earlier reports (e.g. Games, 1983; Tweheyo, Amanya & Turyahabwe, 2010; Kingdon, 1982; Ocen & Andama, 2002) that *C. papyrus* were important sitatunga food. We found that dependence on sedges creates a conflict between the sitatunga and humans who use sedges for a number of purposes (e.g. thatching for houses and craft making). In the event that sedges are heavily utilized by humans, other fallback foods are thus important components in the sitatunga diet.

Another important component of this study was the use of indirect methods, i.e., vegetation sampling and microhistological analysis, to assess the diet. This is important because antelopes studies (e.g. Games, 1983) reported that

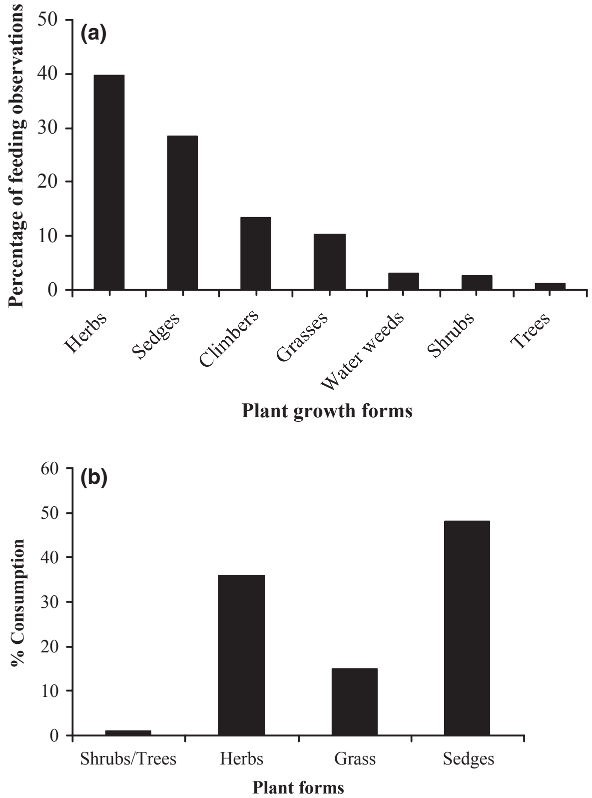

Fig 1 Percentage frequency observation of different plant growth forms eaten by sitatunga in Rushebeya-Kanyabaha wetland. Data collected between January and December 2008 and the diet contribution determined by (a) vegetation sampling and (b) microhistological faecal analysis

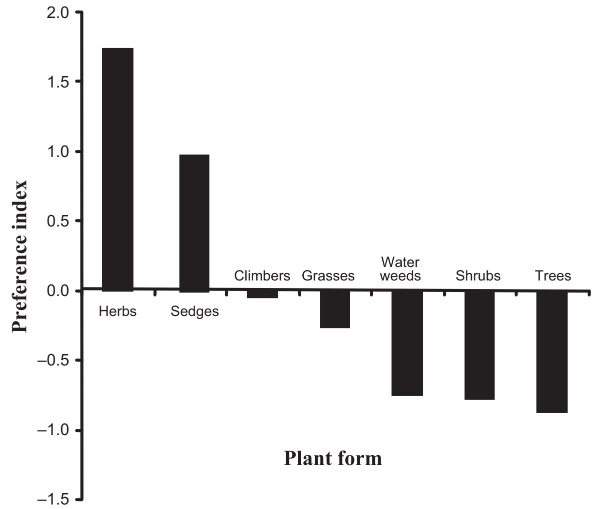

Fig 2 Relative use of plant form as food by sitatunga in Rushebeya-Kanyabaha wetland between January and December 2008. Preference index is taken as the standardized Z-score of the species count of plant form eaten based on vegetation sampling only

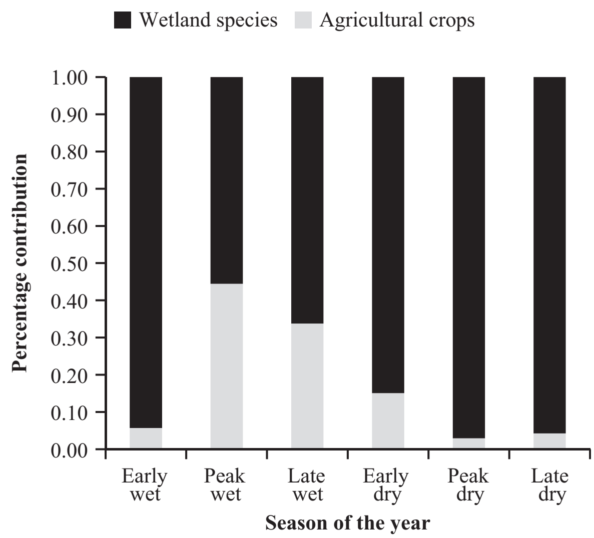

Fig 3 Seasonal variation of sitatunga diet in Rushebeya-Kanyabaha wetland. Data collected between January and December 2008

the sitatunga is a difficult mammal to observe and study, given its cryptic nature and unique habitat, but these indirect methods enabled us to describe the sitatunga diet and habitats. As reported in related studies (e.g. Johnson, Wofford & Pearson, 1983), vegetation sampling varied from microhistological faecal analysis where sedges were eaten more than forbs and grasses. The reason for the difference could be that microhistological faecal analysis underestimates the generally easily digested herbs and overestimates grasses and grass-like species such as sedges, which are less digestible (Holechek, Vavra & Pieper, 1982; Johnson, Wofford & Pearson, 1983).

The sitatunga feeding patterns involved moving out of the wetland to the cultivated fields in search of food. This observation is consistent with other findings (e.g. Tweheyo, Amanya & Turyahabwe, 2010) and can be attributed to the fact that during the wet season, the sitatunga is attracted by the tender and nutritious crops available on farm. In addition, during this period, the wetland is too waterlogged to constitute sitatunga food; however, this finding is contrary to Owen (1970), who reported that the sitatunga showed no seasonal changes in feeding behaviour, but is consistent with Games (1983), who reported

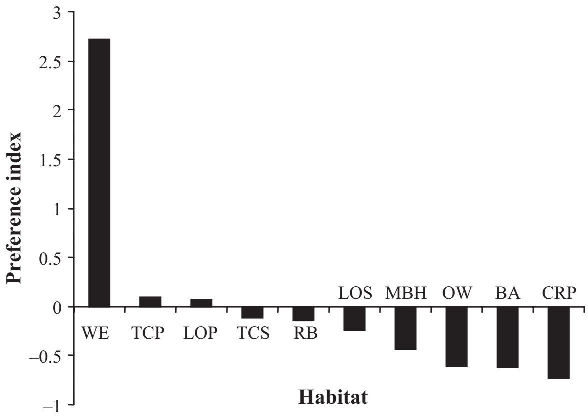

Fig 4 Relative use of habitats for feeding by sitatunga in Rushebeya-Kanyabaha wetland, south-western Uganda. Preference index is calculated as the standardized Z-scores of the feeding frequencies within each habitat. The habitats are described as wetland edge (WE), tall closed papyrus (TCP), light open papyrus (LOP), tall closed sedges (TCS), river boundary (RB), light open sedges (LOS), marshy boggy habitat (MBH), open water (OW), burnt area (BA) and cleared & regenerating papyrus (CRP)

seasonal changes in sitatunga diet in the Okavango delta in Botswana. This trend of extending feeding ranging patterns during periods of food scarcity has been observed in other animal species (e.g. Tweheyo & Lye, 2005).

The sitatunga raiding of agricultural crops during the wet season is a cause of conflict with local farmers and is already reported as one of the reasons why it is hunted (MWLE & KDLG 2001). This study shows that among the raided crops, maize is the most preferred but is also the most important human cereal in this region. Therefore, given the pressure on the wetland to provide arable land and the sitatunga–human conflict caused by sitatunga crop raiding, there is a need for a multidisciplinary approach involving the local people and the wetland managers to conserve the species.

Habitat use

The abundance of feeding signs in the wetland edge and the observed decline towards the wetland centre may be attributed to the concentration of preferred eaten plant species around wetland edge. As recorded in Kenya (Owen, 1970), the wetland edge has mixed herbaceous vegetation offering the necessary nutrition and the best view of potential predators. In addition, the edge effect results in more abundance of young papyrus shoots and floral parts that are preferred by sitatunga (Games, 1983). Sitatunga feeding on wetland edges has important implications for its survival because wetland edges are impacted most by human activities. Therefore, attempts to protect the wetland should target the wetland edge as a starting point.

The tall closed papyrus offers hiding places for the sitatunga from hunters especially during the day and is the only hiding place left for the sitatunga to escape predators. The challenge within this habitat is that there is a likelihood of over exploitation of the papyrus for craft making and building materials by local people. Thus, continued survival of the sitatunga in this region will depend on how well this habitat is maintained.

We conclude that future efforts should be directed in finding solutions that will divert local people from overreliance on the wetland for their livelihoods. Also, other studies are required to determine the population of the sitatunga in the wetland because this will help to establish the carrying capacity of the wetland in terms of the sitatunga food and habitat requirements. This will provide information to guide future management of this wetland in particular, and the methods may be used by other tropical wetlands with similar challenges.

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