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Wildlife mortality on foot paths of the University of Dar es Salaam, Tanzania

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Abstract: Human population on the University of Dar es Salaam, Mlimani Campus, has increased substantially in recent years. It is expected that the number of small animals trampled and killed by pedestrians is correspondingly increasing but no baseline study has hitherto been conducted. Between May 2007 and August 2008, over 1,000 animals trampled by humans walking along foot paths at the main Campus of the University of Dar es Salaam, Tanzania, were identified and enumerated. Human presence along foot paths was also recorded as well as animals killed by vehicles on roads of the campus and surrounding areas. Variations between foot paths, months, seasons and level of human abundance were examined. Invertebrates were the most common animal kills on foot paths while most vertebrate kills were along roads. Foot path deaths peaked during semester periods when pedestrian numbers increased. Types and numbers of animals killed differed between foot paths, apparently in relation to adjacent habitat. Tunnels placed at various sections of the paths would facilitate small animals crossings and reduce mortality. Despite having the highest concentration of pedestrians, a bridge path (path C) scored one of the lowest death tolls.

Resumen: La población humana en la Universidad de Dar es Salaam, Campus Mlimani, ha aumentado substancialmente en años recientes. Es de esperarse que el número de animales pequeños pisoteados y matados por los peatones se incremente de forma proporcional, pero hasta ahora no se ha realizado ningún estudio de base. Entre mayo de 2007 y agosto de 2008, más de 1,000 animales pisoteados por los humanos que caminaban por los senderos en el campus principal de la Universidad de Dar es Salaam, Tanzania, fueron identificados y enumerados. La presencia humana a lo largo de los senderos también fue registrada, así como los animales que murieron atropellados por vehículos en los caminos del campus y áreas aledañas. Se examinaron las variaciones entre senderos, meses, estaciones y el nivel de abundancia humana. Las muertes animales más comunes sobre los senderos fueron de invertebrados, mientras que la mayoría de las muertes de vertebrados tuvieron lugar en los caminos. Las muertes en los senderos tuvieron su pico durante los períodos semestrales, cuando aumentó el número de peatones. Los tipos y los números de animales muertos difirieron entre senderos, aparentemente en relación con el hábitat adyacente. Túneles colocados en varias secciones de los senderos podrían facilitar el cruce de animales pequeños y reducir su mortalidad. A pesar de tener la mayor concentración de peatones, un sendero con puente (sendero C) ostentó uno de los conteos más bajos de muertes animales.

Resumo: A população humana na Universidade de Dar es Salaam, Campus Mlimani, tem aumentado substancialmente nos últimos anos. Antecipa-se que o número de animais de pequeno porte pisoteado e morto por pedestres é cada vez maior, se bem que nenhum estudo de base tenha sido efectuado até agora. Entre Maio de 2007 e Agosto de 2008, mais de 1.000 animais, queforam identificadas e enumeradas, forampisoteados pelo homem transitando pelos trilhos pedestres no principal campus da Universidade de Dar es Salaam, na Tanzânia. A

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presença humana ao longo dos caminhos pedonais também foi registada, assim como dos animais mortos por veículos nas estradas do campus e arredores. As variações entre os caminhos pedonais, meses, estações e nível de densidade humana foram igualmente examinadas. Nos caminhos pedonais, os invertebrados foram os animais mortosmais comuns, enquanto a maioria dos vertebrados foram mortos ao longo das estradas. O número de mortes teve um pico durante os períodos de semestre, quando o número de pedestres aumentou. Os tipos e números de animais mortos diferiram entre caminhos pedonais, aparentemente, em relação ao habitat adjacente. Os túneis colocados em várias secções dos caminhos deverão facilitar a travessia de pequenos animais e reduzir a sua mortalidade. Apesar de ter a maior concentração de pedestres, uma ponte de passagem (percurso C) marcou umadas mortalidades mais baixas.

Key words: Animal mortality, foot paths, pedestrians, University campus.

Introduction

About 17 % (50,889 km^2) of the Eastern Africa's coastal land constitutes the Coastal Forest of Eastern Africa Hotspot which is globally known for its high levels of biodiversity and endemism (Howell 1973a,b; Kasigwa & Howell 1975; Kuper *et al.* 2004; Mittermier *et al.* 2004; www.biodiversity hotspots.org/xp/hotspots/ coastal_forests/). In Tanzania, the level of protection of indigenous habitats on the coastal areas is low (McGinley 2008).

Human population in Dar es Salaam and the entire coastal belt of Tanzania is increasing rapidly, largely from immigration. This area is increasingly subjected to settlements, cultivation, mining for gravel and sand and livestock grazing (Shaabani 2006). As such, there is growing pressure on indigenous plants and animals as disturbance of the natural habitat may lead to reduction in biotic abundance and diversity (Henry 2007; Howell 1978; Nachihangu 2007; Nkane 2002; Ntabaye 2004). Much of the coastal biota has known uses for food, medicine or building material (Cosmas 2007; Heine & Legere 1995; Mbuya *et al.* 1994). Conservation of these resources is critical to ensuring ecosystem maintenance.

Animal mortality due to vehicle collisions is a global conservation issue (Anon. 2003; Drews 1995; Phicox *et al.* 1999; Pienaar 1968; Van der Hoeven *et al.* 2009). Similarly, animals may also be trampled by people on foot paths, yet this has not been given due consideration. Student population on the University of Dar es Salaam Mlimani Campus (hereafter UDSM) has rapidly increased and presently stands at > 14,000 (Anon. 2009; Mkude & Ishumi 2004). This has subsequently increased traffic along campus foot paths. It can be hypothesised that there is substantial small animal mortality caused by pedestrians on campus and that this would relate to habitat type, volume of human traffic and season. In the present study, I quantified foot path animal mortality and relate this to varying human pressure, season, and habitat.

Materials and methods

Study area

The main campus of UDSM (about 6 km^2) is situated about 10 km north of the Dar es Salaam city centre (6° 46' S - 6° 47' S, 39° 12' E - 39° 14' E) at 40 - 100 m above sea level, on the western coast of the Indian Ocean. It falls within the Zanzibar Inhambane Region Mosaic vegetation and receives over 1,100 mm of rainfall per year (White 1983). Annual temperatures average about 24 °C and humidity can reach 100 % in January, February and March.

Construction of the UDSM infrastructure started in the early 1960s on the largely hilly area popularly known as Mlimani. The area was largely a bushland with scattered huts and pockets of permanent and seasonally cultivated crops including cassava (*Manihot esculenta*), cashew nuts (*Anarcadium occidentale*), coconuts (*Cocos nucifera*), mango (*Mangifera indica*) and rice (*Oryza sativa*). The bulk of construction was completed by the mid- 1970s; presently about a quarter of the campus area is occupied by buildings, roads and foot paths. Most of the roads are tarmac while about a third of the foot paths are concrete surfaced. In the last 20 years the UDSM campus

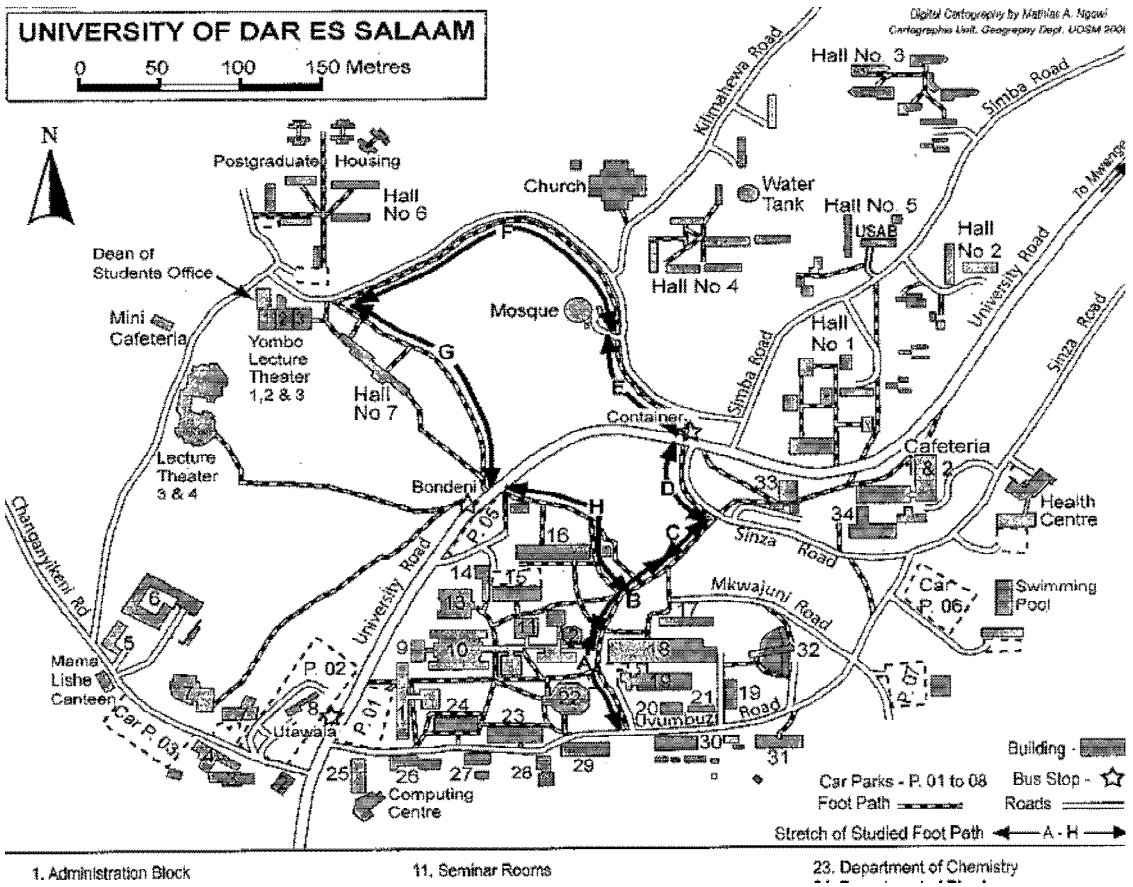


Fig. 1. Map of main activity part of the UDSM Mlimani Campus (Tanzania) showing studied foot paths (A - H).

has experienced an appreciable recovery of indigenous vegetation due to protection from wood collection and cultivation. Areas in the immediate vicinity of buildings, roads and foot paths are regularly mowed and these have developed into largely wooded grasslands (Manyama 2009; Suma 2009). Presently, UDSM stands out as a habitat island mostly vegetated by indigenous plants surrounded by high density human settlements.

Methods

I conducted a one year systematic study of animals killed on foot paths between May 2007 and August 2008. I also collected opportunistic records of animals killed on the roads and on foot paths. Eight stretches of foot paths were walked daily except for a few days (Fig. 1). Each morning, between 0600 - 0900, myself and an assistant walked along the foot paths recording any dead or dying animal that appeared to have been trampled. Occassionally, surveys were conducted between 1230 - 1400 h and 1530 - 1630 h. Surveyed foot path segments ranged between 60 and 275 m in length (Table 1); total length was 1,1190 m.

Number of pedestrians along foot paths during semester (mid-September - mid-January) and non-semester (February - June) periods was recorded during the afternoon (1230 - 1400 h). Semester time is defined as the period when regular undergraduate programmes were in session. Finally, an assessment was made of habitat characteristics along the foot paths walked including coverage of infrastructure, overall vegetation cover, woody plants (trees and shrubs) cover and herbaceous (grasses) cover. The ensuing animal mortality data were collated, quantified and analysed for variations between foot paths, habitats, months, seasons and number of pedestrians.

It was expected that more deaths would occur on longer path stretches and that habitat around a path would determine the type and number of animals trampled. Regression analysis was performed to relate level of mortality (response) with path length (predictor). Regression was also performed to relate amount of infrastructure, vegetation cover, tree cover, and herbaceous cover (predictors) with death toll (response). Semester and non-semester death tolls were compared using

Table 1. Lengths and habitat characteristics (within 10 m on either side) along foot paths walked for assessing animal kills at the UDSM Mlimani Campus, Tanzania. May 2007 - June 2008. T = overall, L = left side, R = right side, Infra = infrastructure, Veg = vegetation, Wood = woody plants (trees and shrubs). *Refer Fig. 1.

Path*	Length (m)	Side	Within 10 m				% Wood (11-20 m)	Notable features within 50 m
			% Infra	% Veg.	% Trees	% Grass		
A	110	T	50	50	10	50	5	Car park, tarmac road and concrete slabs
		L	20	80	10	85	5	Nkuruma (assembly) hall
		R	85	15	5	35	5	Main library building
B	75	T	5	95	90	20	8	Concrete slabs, cool
		L	5	95	90	2	10	Borders with drainage system
		R	2	95	90	30	6	Students' reading ground/lawn
C	60	T	5	95	90	50	60	Bridge, cool, high human traffic
		L	5	95	90	50	60	Mostly valley
		R	5	95	90	50	70	Mostly valley
D	75	T	10	80	8	40	10	Besides a tarmac road
		L	2	90	10	90	10	Mowed grass
		R	18	60	9	60	10	Mowed grass, tarmac road
E	180	T	10	80	40	50	80	Woodland
		L	3	90	70	50	90	Mowed grass, thicket, mosque
		R	20	60	10	60	80	Mowed grass, tarmac road
F	275	T	12	90	80	10	90	Low pedestrian traffic
		L	2	90	90	5	95	Bush thicket
		R	22	80	70	15	90	Church, tree nursery, dormitory
G	240	T	5	90	60	40	70	Concrete slabs, heavy traffic
		L	3	90	70	20	85	Mowed grass, thicket, dust bin
		R	8	90	50	50	60	Mowed grass, dormitory
H	175	T	8	80	9	80	8	Mowed grass L and R
		L	5	90	10	80	10	Drainage valley
		R	15	80	8	70	5	Restaurant, office building

the Wilcoxon sign test. The number of pedestrians walking two selected paths C and G were compared using the Mann - Whitney test. It was also expected that level of mortality would be related to the number of people walking a path stretch. A regression analysis was performed to test this prediction. Coefficient of Variation (CV) for a predictor or response was worked out as % standard deviation divided by the respective mean. Statistics were carried out using InStat Graph Pad Software (http://www.graphpad.com/instat/instat.htm) and Minitab 14 Statistical Software (http://www.minitab.com/). Cut-off level for significance was 0.05.

Results

Stretches of foot paths differed in their habitat characteristics (Table 1). Stretch A was dominated by infrastructure; stretches B and C by a thick canopy cover of an over 20 m tall exotic tree, *Ficus benjamina,* and a thick ground layer of leaf litter. Stretch C also included a converging bridge (the Academic Bridge) linking two main paths from the main library and lecture rooms to residential and dining halls. Stretch D was a wooded grassland and constituted a tarmac road and an unpaved foot path. On the left sides of stretches E, F and G was

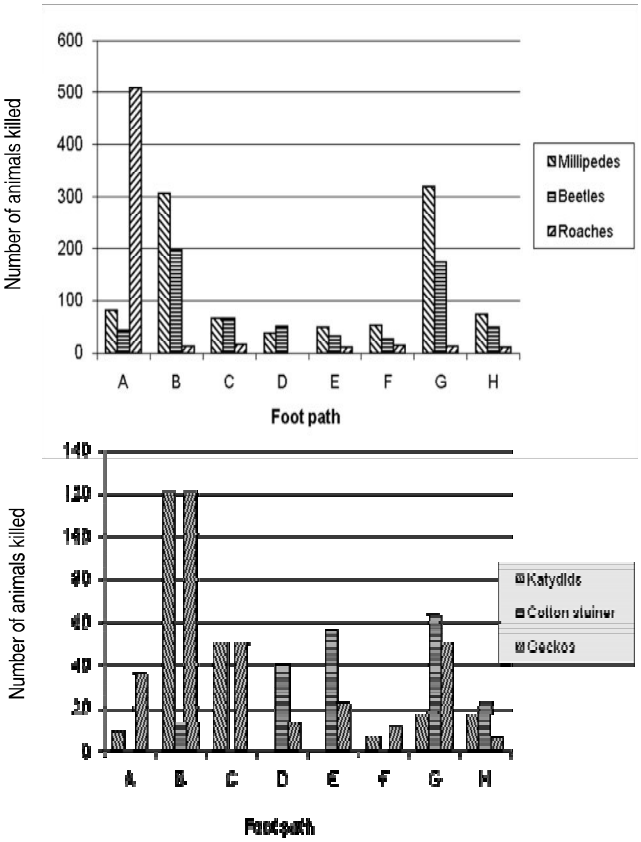


Fig. 2. Top and bottom: Number (km^{-1}) of six most common animals (or animal groups) killed on foot paths at the UDSM Mlimani Campus, Tanzania. May 2007 - June 2008. Abbreviations as in Fig. 1.

a thicket (approximately 4 ha) of mostly indigenous plants with small patches (about 15 % of the thicket) of fallow lands that were formally cropped with cassava (*Manihot esculenta*) and sugar cane (*Saccharum officinarum*). Their right sides had mowed grass, buildings and foot paths; those of stretches E and F were also bordered by a tarmac road. Stretch H was along a mowed grass area bordered to the left by a wet valley that also occasionally acted as drainage of spill off from residential and dining halls. To the right, it had office and class room buildings and the stretch ended into the *F. benjamina* forest patch at path B (Fig. 1).

Over 1,000 individuals of a variety of species were found trampled along the foot paths. Kills varied between places and months (Figs. 2 & 3). The most common groups were millipedes, beetles, roaches, katydid, cotton stainers and geckos (Fig. 2; Table 2). Millipedes, beetles, geckos and katydid were most abundant at paths B and G that had good tree canopy cover. Roaches were third in kill abundance but were largely (> 90 %) found on path A which was heaviest on infrastructure. Infra-

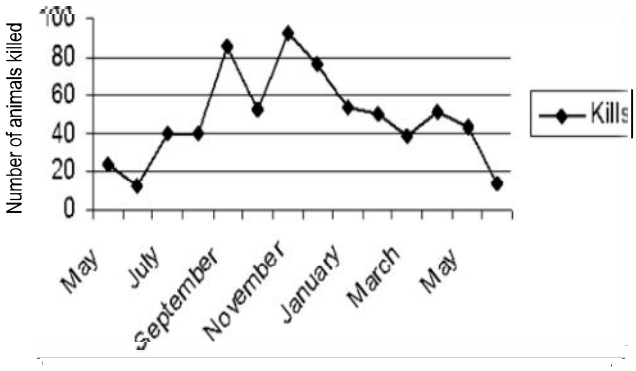


Fig. 3. Number of animals killed along foot paths. UDSM Mlimani Campus, Tanzania. May 2007 - June 2008.

structure was a significant predictor of roach kills (Table 3). Cotton-stainers were mostly in paths E and G that were in woodlands where the herbaceous layer was constantly mowed. To the left, paths E and G were bordered by a thicket dominated by the shrub *Thespasia danis* whose fruits are a favourate of cotton-stainers. Among the butterflies found killed along the roads on campus was the forest dependent *Salamis parhasus*.

A variety of vertebrates and invertebrates were trampled on foot paths and roads (Table 2; Figs. 2 & 4a,b) at UDSM. Over 85 % of the foot path deaths were invertebrates. For each path, different animal groups were killed in very different numbers (CV = 121 - 176; Table 2). Foot path length did not significantly influence death toll (R^2 = 0.26; F = 2.05; P = 0.202). There was big variation in both abundance of people on foot paths and the number of animals killed (CV = 84.6 for people and 64 for animals killed; Fig. 5). Considering the total for all path stretches, the influence of number of pedestrians on death toll was statistically insignificant (R^2 = 0.093; F = 0.62; P = 0.462). More animals were killed during the semester than off semester periods (W = 28.00; P < 0.05; Fig. 6). Foot path deaths during semester periods were over 160 % higher than during off semester. For foot paths C and G, which had high concentrations of pedestrians, the number of people walking was 300 % higher during the semester than off-semester; the difference was significant (W = 36; P < 0.05).

Peak deaths occurred around November and December, corresponding to the onset of a brief rains period. This was particularly the case for the toad *Amietophrynus gutturalis,* one of the common amphibians in UDSM (Fig. 7). Invertebrates were the most affected animals along the foot paths; verte-

Table 2. Number (km^{-1}) of animal groups (morphospecies) killed along foot paths in the Mlimani campus of UDSM, Tanzania. May 2007 - June 2008. ( ): Taxa higher than Family or Order.

Animal group	Family / ORDER	Foot path/ Kills km^{-1}							
		A	B	C	D	E	F	G	H
Millipedes	Julidae	82	307	67	40	50	55	321	74
Beetles	COLEOPTERA	45	200	67	53	33	29	175	51
Ants	Formicidae	0	133	83	0	6	0	279	86
Mantids	MANTODEA	18	93	17	0	6	11	21	6
Cockroaches	Blattidae	509	13	17	0	11	15	13	11
Grasshoppers	ORTHOPTERA	45	0	0	13	28	36	50	11
Moths	LEPIDOPTERA	18	0	33	0	6	7	25	23
Locusts	ORTHOPTERA	18	53	17	13	33	15	4	6
Katydids	Tettigoniidae	9	120	50	0	0	7	17	17
Wasps	HYMENOPTERA	9	0	17	13	17	0	83	0
Insect Larva	(INSECTA)	0	0	0	0	0	0	50	29
Crickets	ORTHOPTERA	9	13	17	40	39	18	29	11
Cotton stainers	Pyrrhocoridae	0	13	0	40	56	0	63	23
Butterfly	LEPIDOPTERA	0	0	0	0	0	4	25	0
Bees	HYMENOPTERA	36	40	33	0	11	7	21	6
Centipedes	Scolopendridae	9	27	0	0	17	15	4	0
Other arthropods	(ARTHROPODA)	18	0	17	0	0	0	50	0
Other insects	(INSECTA)	18	53	17	0	11	11	25	6
Other frogs	ANURA	27	0	0	0	11	11	0	6
Water bugs	COLEOPTERA	0	0	0	0	0	4	21	23
Spiders	ARANEAE	9	13	0	0	22	11	4	6
Dragonflies	ODONATA	9	13	0	0	0	0	0	0
Casstle builders	(ARTHROPODA)	0	0	0	13	0	0	13	17
Geckoes	Geckonidae	36	120	50	13	22	11	50	6
Snakes	SERPENTES	27	13	0	0	11	7	25	11
Bufo &ranas	ANURA	18	0	0	13	0	7	0	0
Other herptiles	(CHORDATA)	0	0	0	0	0	0	8	0
Total		969	1224	502	251	390	281	1376	429
Average		36	45	19	9	14	10	51	16
STDEV		96.39	74.13	25	15.55	16.11	12.59	80.30	21.84
% CV		268.6	163.5	131.6	167.2	111.6	120.9	157.6	137.5

brates were mostly killed along the roads. Recorded road kills (Fig. 4) included the following: house rats (*Rattus rattus*), Giant cane rat (*Thryonomys* sp.), other rodents, genets (*Genetta* sp.), vervet monkeys (*Cercopithecus eathiops*), lesser galago (*Galago senegalensis*), domestic dogs (*Canis familiaris*), domestic cats (*Felis catus*), hedge hogs (*Atelerix* spp.), civet cats (*Vivera civetta*), banded mongoose (*Mungos mungo*), snakes (mostly *Psamophis* spp.), skink (*Mabuya varia*), bufo (*Amietophrynus gutturalis)*, other frogs, and terrapins (*Pelusios* spp.).

Geckos and katydids were most prevalent in foot path B which had a thick canopy cover of the exotic tree, *Ficus benjamina*. Dead roaches (*Periplaneta americana*) were largely found on path A which had the largest infrastructure of buildings, road, a parking lot and concrete slabs. Millipedes and beetles were found on all foot paths but were most common on paths B and G. Path G had a thick moist bush thicket to the left and high statured woodland dominated by *Pteleopsis myrti-*

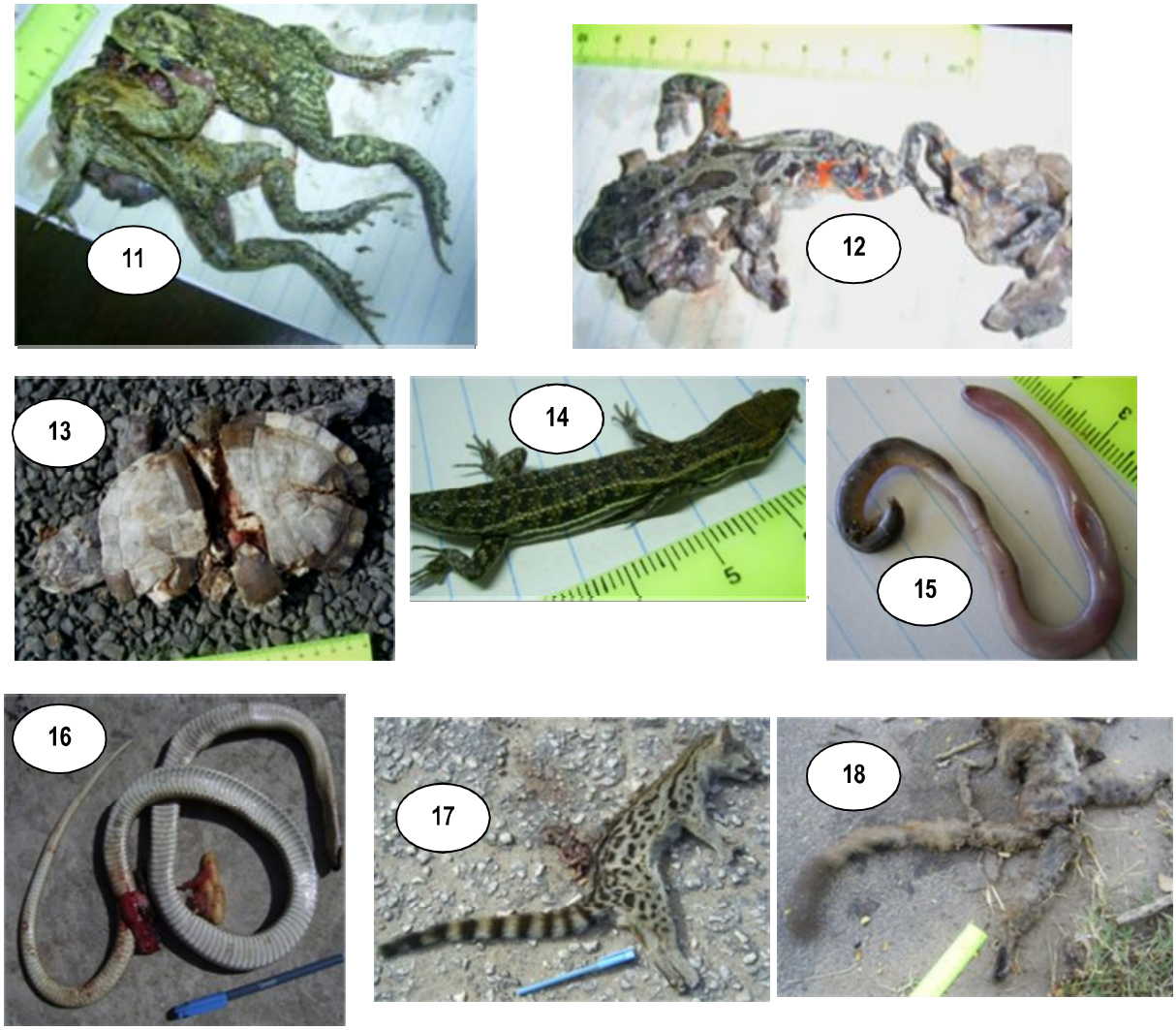


1: Large Black Nest Chafer (Diplognatha); 2: Eyed Jewel Beetle (*Lampetis*); 3: Burrowing Grasshopper (*Acrotylus*); 4: Carpenter Bee (*Xylocopa caffra*); 5: Leaf Katydid (*Zabalius*); 6: Butterfly (*Danaus chrysippus*); 7: Butterfly (*Papilio demodocus*); 8: Burnet Moth (*Neurosymploca*); 9: Centipede (*Scolopendra*); 10: Millipede: (*Archirospirostreptus*).
Fig 4a

folia on both the left and right sides. The cotton stainer is a very common insect on foot paths in UDSM but it was not recorded on paths A, C, and F, and was very scanty on path B. This suggests it may prefer open habitats with scattered trees and shrubs.

Discussion

Some patterns have emerged on the animals killed along the foot paths. Arthropods constituted the bulk of the foot path mortality. The slower moving animals, notably millipedes (Julidae), consti-



11: Bufo (*Amietophrynus gutturalis*); 12: Running Frog (*Kassina*); 13: Terrapin (*Pelusios*); 14: Variable Skink (*Mabuya varia*); 15: Blind Snake (*Typhlops*); 16: Snake (centipede eater); 17: Genet (*Genetta*); 18: Bush Baby (*Galago*).
Fig 4b.

Fig. 4 a & b. Sample animals killed on foot paths and roads at the Mlimani campus, UDSM, Tanzania. 2007 - 2008.

tuted the most frequent mortalities. However, faster moving and even flying animals were also among those trampled. Most flying insects (such as butterflies) are very active and mobile during the day; however, they are often docile in early morning hours before temperatures become warmer. A katydid (*Zabalius* sp.) was spotted at 0630 on path A; attempts to make it fly failed and by 1000 it had been trampled.

Generally, foot paths with the greatest pedestrian traffic also recorded high levels of trampled animals. Foot path kills were higher during semester session than off-semester, suggesting that pedestrian volume increased death toll. Paths running through areas with thick and diversified vegetation e.g. path G, recorded proportionally higher death tolls in absolute numbers as well as types of animals suggesting individual species may have been killed in relation to their relative abundance in respective habitats. Weather conditions also affected activity of the animals, especially invertebrates (Martin *et al.* 1994; Mushi 2004), and may have influenced death toll.

The high frequency at which killed millipedes were encountered is in agreement with their high abundance on the campus as revealed by previous studies. Keraryo (1994) recorded millipedes constituted 9.24 % of the abundance of litter fauna at UDSM and were exceeded only by cockroaches (Blatidae), ants (Formicidae), and woodlice (Porce-

Table 3. Relationships between habitat (predictor) and death toll (for five selected animals) along foot paths at the UDSM Mlimani Campus, Tanzania. 2007 - 2008. Veg = vegetation; infrastr = infrastructure.

Equation	R^2	F	P
Gecko = 399 - 4.78 veg + 1.47 trees - 2.93infrastr	0.463	1.15	0.431
Roach = 230 - 3.98 veg + 1.06 trees + 9.18infrastr	0.972	45.75	0.001
Millipede = 747 - 8.1 veg + 2.59 trees - 6.3infrastr	0.218	0.37	0.779
Beetle = 303 - 3.0 veg + 1.21 trees - 2.8infrastr	0.261	0.47	0.719
Katydid = 163 - 2.04 veg + 1.04 trees - 1.39infrastr	0.434	1.02	0.471

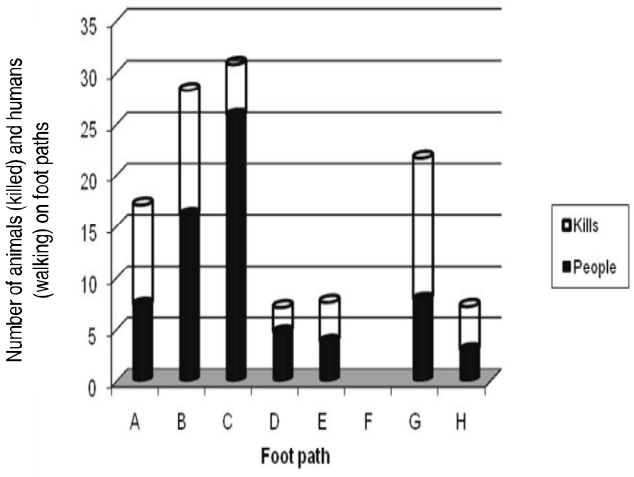


Fig. 5. Number of animals killed (100 m^{-1}) along the foot paths in relation to the abundance of humans walking (m^{-1}) the paths at the Mlimani campus, UDSM, Tanzania. May 2007 - June 2008.

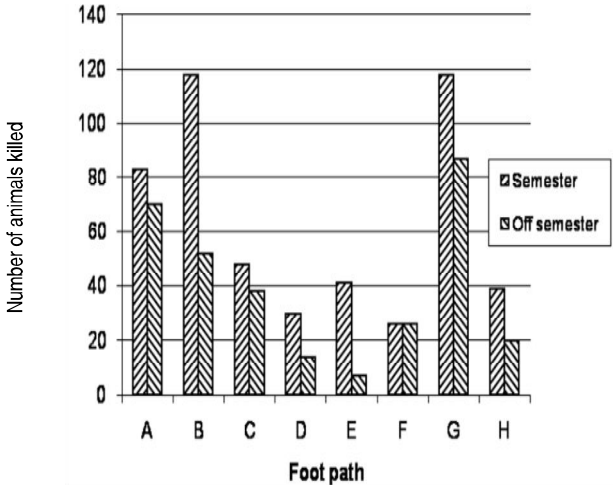


Fig. 6. Total number of animals killed (y-axis) on the foot paths during semester and off semester periods at the UDSM Mlimani campus, Dar es Salaam. May 2007 - June 2008.

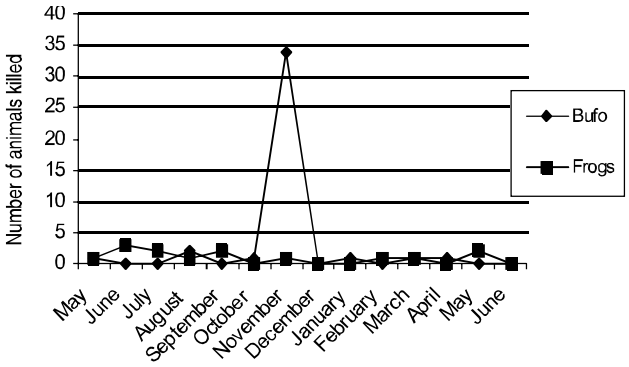


Fig. 7. Dead *Amietophrynus gutturalis* (Bufo), and other frogs on foot paths and roads of the Mlimani UDSM campus and surrounding areas. May 2007 - June 2008.

llionidae). Mohan (2001) noted that Diplopods were highest in pitfall traps set in a bush thicket on the campus. As millipedes are slow movers and coil still when approached, this may put them at greater risk of being trampled. They also feature high in death toll along roads and foot paths in Amani Nature Reserve, Tanzania (Senzota 2004). Deaths of the millipedes and beetles were also highest on the paths under thick cooler woodlands and this agrees with their overall higher abundance in such habitats at UDSM (Ahmed 2007; Likonda 2005; Mahudi 2004; Mohan 2001).

On UDSM, geckos are abundant around buildings (Msyani 1991). In this study, they were abundantly killed on paths B and G both of which had long poled trees. Path B was characterized by *Ficus* trees with long hanging roots and huge buttresses that might have provided good habitat for prey insects such as beetles, which were abundant on this path. A long residence hall parallel to path G, was mostly full lighted at night, providing further attraction to insects and geckos.

Peak deaths were recorded in November and December, coinciding with the onset of the rains. This was particularly the case for the toad *Amietophrynus gutturalis* (nee *Bufo gutturalis*), the most abundant anuran on the UDSM campus (Mwombela 2001), that was recorded in very high numbers during November 2007. On the UDSM

campus and elsewhere on the coast, anurans have the tendency to move in big numbers searching for temporary breeding ponds at the onset of the rains (Msuya 2001; Mwombela 2001).

Foot path C recorded one of the lowest death tolls despite its being next to path B and having a similar vegetation type. About 70 % of path C was a bridge over a seasonal drainage system. While it had the largest number of pedestrians, animals moving across were apparently traveling underneath the bridge thus avoided being trampled. This observation suggests installing tunnels at various sections of the paths would improve safe passage of small animals, as has been suggested and practiced elsewhere (Anon. 2003). Speed limits on campus roads should be actively enforced as a safety precaution for both wildlife and humans.

The UDSM Mlimani campus may play an important role as habitat refugia for urban wildlife of the Global 200 East African Coastal Forest Ecoregion (Burgess & D'Amico 2009). Efforts to sustain this biota are worthwhile. Although the bulk of foot path kills were largely inconspicuous, they constitute prey of vertebrate species such as reptiles, vervet monkeys (*Cercopithecus aethiops*) and genets (*Genetta* sp.) (Masunzu 1992; Msyani 1991). Some can also be used in identifying human – parasite interactions. Geckos on UDSM have been found to host four groups of intestinal parasites (Pentastomida, Nematoda, Cestoda and Trematoda), although none of the parasites collected appeared to infect humans (Msyani 1991; Simonsen & Sarda 1985). The coastal forests of the Eastern Africa Biodiversity Hotspot, close to Dar es Salaam, face the biggest conservation challenges from incursions for settlements, as well as charcoal burning, fuel wood harvesting, agriculture and logging (McGinley 2008). Increasingly, places like UDSM will be important strongholds of some indigenous biota provided conservation of wildlife is considered by university administrators.

Mowing and sweeping adjacent to foot paths, that are regularly done by campus groundskeepers and gardeners, could also be practiced only to the extent they are absolutely necessary. These activities not only remove habitats for many small animals, they may also increase levels of soil erosion. While leaving intact the herbs, leaf litter, and other understorey debris may not be aesthetically attractive, particularly to horticulturalists and landscape gardeners, this may go a long way to improve habitat conditions for reptiles, small mammals, and birds that are increasingly becoming an attraction to residents and visitors.

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