In the shadow of mammals: the use of camera traps to investigate the basking behaviour of *Agama mwanzae* in the Serengeti National Park, Tanzania

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ABSTRACT - Camera trap images from the Snapshot Serengeti project from 2010 were used to investigate the behaviour of rock agamas (*Agama mwanzae*) on the kopjes of the Serengeti National Park, Tanzania. The species was observed only from four locations in the south-west of Serengeti in September/October. The images were used to analyse the total numbers of basking individuals, the proportions basking morning or afternoon, and to determine what other reptile species used the kopjes as refugia or for basking. Many more females were observed basking than males, this was expected as the species lives in colonies based on a single dominant male. Numbers of males basking in the morning and afternoon did not differ but significantly more females were observed basking in the afternoon. Based on this study *A. mwanzae* appears to be virtually the only species inhabiting kopjes in the south-west of the Serengeti National Park but camera traps may be less likely to detect smaller species.

INTRODUCTION

Since 2010, the Snapshot Serengeti Project has deployed 225 camera traps across an area of 1,125 km^2 in the Serengeti National Park, Tanzania to help evaluate both spatial and temporal inter-species dynamics (Swanson et al., 2015a). This data has since been analysed by both the wider scientific community and members from the project to provide insights into the project's original aims, related to mammalian carnivores. With such a large dataset available there are of course many questions that can still be answered and fortunately the data is freely available online (Swanson et al., 2015b). The data was the basis of the current study to answer questions regarding the behaviour and activity of the Mwanza flat-headed rock agama (*Agama mwanzae*) and other reptiles which also inhabit the Serengeti National Park.

Static camera traps are a common method used to observe the behaviour of wildlife without influencing its behaviour; they have become more popular in ecological studies since the introduction of commercially available units in the 1990's (Kucera & Barrett, 2011). The advance of technology has also played a crucial role in their uptake with modern camera traps able to collect photos and videos in high quality formats, no matter the weather or time of day. Technological advances in battery technology have also allowed traps to remain in-situ for longer resulting in more capture days per season (Swann et al., 2011). Cameras are usually fitted with infrared or movement sensors which trigger the camera to take a series of photos or a video. Exotherms such as mammals are more likely to trigger such cameras than smaller ectotherms such as reptiles and amphibians (Ariefiandy et al., 2013).

Agama mwanzae is a relatively large diurnal agamid that lives on boulders and rocky outcrops (Spawls et al., 2006).

Figure 1: A male *A. mwazae* basking on a rock outcrop, captured by one of the camera's traps

The species is fairly common in northern Tanzania and the most dominant agamid in terms of abundance; the visually similar red-headed agamid (*Agama agama*) is absent from the area of this study (Spawls et al., 2006). Mature males have a bright red/pink upper body and a blue lower body (Fig. 1) while females are a grey-brown colour and are less ornate than mature males (Fig. 2). Their large body size combined with easily distinguishable colouration and known behaviour is ideal for posing retrospective questions related to basking and activity. Snapshot Serengeti placed some of their cameras between rocky outcrops and kopjes in the hope of determining whether or not they were being used by mammals as corridors. From the original dataset, 131 capture events containing reptiles were originally identified (Swanson et al., 2015b), they were used as a starting point for this study with the hope of finding more events that the wider scientific community had overlooked.

Figure 2: A female *A. mwanzae* photographed basking on a rock outcrop at the Serengeti National Park, Tanzania

MATERIALS AND METHODS

The dataset came from the 2010 season (June-November) of the Snapshot Serengeti Project, when DLC Covert II camera traps (5 MP CMOS camera with 40˚ FOV) were being used at 50 cm above ground level. During 2010, only 200 camera traps were used with each of the cameras placed towards the centre of a 5 km^2 grid cell to allow a systematic coverage (Swanson et al., 2015a). Trapping events are defined by a single series of three photos taken one second apart when the camera traps are triggered. Using the dataset provided by the project online, camera trapping events were investigated in batches of 36 (108 images) in order to look for the presence of reptiles, including the target species *A. mwanzae*. The events originally identified by the wider scientific community were used to first establish which areas were suitable for use by *A. mwanzae* and then later to further establish times of the day when it was most likely that the trapping event was triggered by a reptile and not passing grazing mammals. Once all of the appropriate capture events had been identified and the files had been downloaded, the photos from each were then analysed. This involved identifying the species in frame, the maximum number of individuals photographed during the event and their sex (Fig. 1). Abiotic factors such as the time of day and date were also recorded in order to allow later analysis. Besides *A. mwanzae*, other reptile species using the kopjes were noted. Individuals of *A. mwanzae* were classified by both their size and colouration into males, females and juveniles. Sub-adults whose gender could not be seen clearly and all juveniles which can't be sexed from photos were excluded from the analysis. Despite what has previously been described by Yarnell & Jones (2001), immature males were seen to have the beginnings of mature colouration, which was used to identify them.

RESULTS

The trapping events with *A. mwanzae* occurred in only four different locations, all towards the south-west corner of the Snapshot Serengeti study area. The traps at the locations where the agamas were observed were only active during September and October in the 2010 season, this is when the camera traps were placed in the field. The cameras at the four sites detected *A. mwanzae* with different frequencies, varying as follows: J13 (n=23), O10 (n=353), T13 (n=407) and U13 (n=2) giving a total of 785 trapping events. Of these, 778 events included individuals of *A. mwanzae* basking, with very little other behaviour observed.

The number of agamas photographed during each capture event varied with only one individual per event being the most numerous (n=621), followed by two individuals (n=141), three individuals (n=20) and finally four (n=3). Of the total trapping events containing *A. mwanzae*; 318 were in the morning (before noon) and 467 occurred in the afternoon. When the numbers of observations of *A. mwanzae* in the morning and afternoon were compared (Table 1) there were significantly more in the afternoon (One-way Chi Square, χ^2= 27.9, df= 1, p= <0.0001).

When looking at the basking behaviour of *A. mwanzae*, significantly more females were observed basking than males, including 4 immature males (One-way Chi Square, χ^2= 5.09, df=1, p= 0.024). The time of day (Table 1) apparently had no effect on the number of males basking (One-way Chi Square, χ^2= 0.14, df=1, p= 0.7083) but more females were basking in the afternoon than morning (One-way Chi Square, χ^2= 52.34, df=1, p= <0.0001). Besides *A. mwanzae*, only one other reptile species, the striped skink (*Trachylepsis striata*), was observed using the kopjes. This species was only seen in two trapping events.

Table 1. The frequency of adult male and female Agama mwazae detected by camera traps during the morning or afternoon (based on peak counts from each camera trapping event)

Time of day	Male	Female	Total
Morning	57	295	352
Afternoon	62	500	562
Total	119	795	914

DISCUSSION

This study showed that camera traps can be an effective way to monitor the behaviour of reptiles such as lizards, despite the fact that they are not commonly used for this purpose. The main result from this investigation is that more female *A. mwanzae* were observed to be basking than males, which is expected given the known social structure of the species (Yarnell & Jones, 2001). More females were seen basking in the afternoon which is a likely consequence of the kopjes having warmed up after the heat of the midday sun, meaning that lizards could gain warmth from both direct sunlight and radiation from the kopjes.

The lack of reptile diversity on the kopjes is startling given the potential benefits that they provide to species wishing to sun themselves. More species may have been using the kopjes than reported as the camera traps may not

have been sensitive enough to have been triggered by their smaller size. In experiments in Australia, Welbourne et al. (2015) found that reptile species with a larger critical mass were more likely to trigger camera traps than smaller ones.

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