**INFLUENCE OF GROUP SIZE ON THE VIGILANCE BEHAVIOUR OF SPRINGBOK (*ANTIDORCAS MARSUPIALIS*) AT THE OKAUKUEJO WATERHOLE IN ETOSHA NATIONAL PARK**

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**Abstract**

Even though vigilance is thought to interfere with foraging, it has proven to be crucial for prey species to ensure their safety from predators. As a result, many mammal species live in groups as a way to reduce the time they spend being vigilance and increase foraging. We video recorded animals at the Okaukuejo waterhole in the Etosha National Park (ENP), mainly focusing on different group sizes of springboks (*Antidorcas marsupialis*) to determine the effect of group size on their vigilance behaviour. There was no significant correlation between the group size and the vigilance behaviour of springbok. Vigilance in springboks did not decrease with increasing group size. Correlation may differ as a function of another unmeasured variable such as sex, presence of the young, age, etc. such that, the expected relationship/ correlation is evident only due to certain factors.

**Keywords**: anti-predatory, feeding activity, foraging, mammal species, predator detection, trade-offs

# INTRODUCTION

Animal behaviour, a concept which broadly consider everything animals do (i.e movement and other activities) (Seeley & Sherman, 2019), is often maximized as a trade-off between survival and reproduction (Wolff & Horn, 2003). Vigilance is critically important for prey species to ensure their safety from predators (Favreau, et al., 2015). Several authors base the factors of group living of mammals on the advantage of food acquisition, while others relate it to predator detection (Quenettte, 1990; Blanchard & Fritz, 2007). In birds and mammals, individuals interrupt their feeding activities to scan their environments for predatory signs (Beauchamp, 2013). Virtually, every method used by a prey species in predator detection is considered a trade-off between feeding and scanning of the environment (Roux, et al., 2009). Foraging and vigilance are considered to be mutually exclusive, such that an animal cannot forage and be vigilant at the same time (Marel, et al., 2019). Many animals live in seasonally varying environments where food availability, as well as the predation risks, also vary with seasons, and they must therefore adjust their behaviour accordingly (Favreau, et al., 2018). For example, predators may change their predatory tactics to attach prey with varying seasons and so should the prey to avoid predator with vegetation height and the presence of offspring can attract predators (Favreau, et al., 2018) .

Furthermore, the trade-offs that many animals need to make between feeding activity and predator detection also need to change with seasons (Favreau, et al., 2018). The greatest major benefit of group living selection by mammals is predator evasion through the process of using group members as cover, increased information exchange between members, dilutions of predation risk, increased predator detection etc. (Marel, et al., 2019). As a result, individuals in a group can decrease their energy input into vigilance with no increased risk to themselves (Beauchamp, 2013). Even though group vigilance increases with group size, individual vigilance is reduced as animals rely on their group members for predator detection and predation risk is diluted among the members of the group (Beauchamp, 2013; Beauchamp, 2008). Vigilance is thought to interfere with foraging, yet many mammal species can continue with food ingestion while being vigilant by raising their heads to scan their surrounding while chewing (Favreau, et al., 2015). This study hypothesize that there is an association between group size and vigilance behaviour of springbok, such that as group size increase, there is a decrease in individual vigilance.

Many studies investigated the factors that contribute to the influence of group size on vigilance behaviour in mammals (Quenette, 1990; Lashley, et al., 2014) because when feeding, vigilance behaviour comes at a cost of reduced intake rates. For prey species, group size is mostly attributed to seasonality, food availability (Favreau, et al., 2018; Quenettte, 1990), increased predator detection (Beauchamp, 2013), social information acquisition (Favreau, et al., 2015), reduced risk of the particular individual being preyed on and possible confusion to a predator by many preys (Quenette, 1990).

Even though the group-size effect on vigilance is thought to be positive, Beauchamp (2013), says the issue of why the magnitude of the effect differs from one species to another is not clear. While grouping is thought to contribute to vigilance behaviour of animals (Quenette, 1990), other factors such as habitat preference, time allocation between scanning the environment and feeding (trade-off), anti-predatory behaviour of the species, presence of the young, social status, sex of the organisms determine the quality of vigilance (Quenette, 1990). In a study conducted by Hunter & Skinner, (1998) showed a negative correlation between vigilance and group size for both predation conditions. Even when predation risk was reduced, there was no change in vigilance behaviour of the impalas and wildebeests, suggesting that even when there is low predation, the anti-predation benefits of grouping can still be detected (Hunter & Skinner, 1998).

Females in a group of herbivores spent more time observing other group members as group size increased and the proportional time spent on being on the lookout for predators in their surrounding decreased with group size (Favreau, et al., 2010). Such vigilance supports the idea of group living reducing time spent by individuals on predator detection while allowing individual vigilance within the group to reduce competition with group members and enhance territoriality (Favreau, et al., 2010). In a similar study, Favreau, et al., (2015) reported that female kangaroos spent more time scanning their surroundings compared to gathering social information from group members. According to Favreau, et al., (2018), the mechanisms behind the seasonal fluctuations in herbivores’ vigilance are often difficult to understand because vigilance and feeding rates are both affected by various environmental, social and individual factors.

Blanchard & Fritz (2007), stated that there are two types of vigilance behaviour exhibited by animals. Firstly routine vigilance was an individual organism match with precision its particular ingestion process and scanning behaviour, and finally, induced vigilance which often enough disrupts feeding process because it requires the animal to react to unpredictable stimuli, most often as a result of other group member’s alertness (Blanchard & Fritz, 2007). During induced vigilance, free-ranging impalas raise their heads faster and stop chewing for a very long time disrupting the feeding process, in an attempt to monitor sounds in the environment compared to routine vigilance when the animals spend little time scanning the environment before they continue chewing (Blanchard & Fritz, 2007). In a study correlating group size to food availability, quality and distribution, it was found that social foragers form larger groups during periods of better food conditions with interspecific competition being reduced, which in turn affect vigilance behaviour (Favreau, et al., 2018).

Although individuals in larger groups benefit from a large number of alert eyes and reduced probability of individuals getting preyed on, individuals foraging in larger groups, however, may suffer increased predation due to increased visibility (Roux, et al., 2009). In a study of effects of ecological and social factors on vigilance behaviour, (Roux, et al., 2009) found that vigilance does not conform to group-size effect when foraging and vigilances are not mutually exclusive. This study aims to investigate the influence of group size on the vigilance behaviour of springboks at the Okaukuejo waterhole in the ENP.

**MATERIALS AND METHODS**

## *Description of the study area*

## *Location and extent*

This study was conducted in Etosha National Park (ENP). ENP is a 22, 915km2 protected area in northern Namibia, with the geographical location between 18º 56’ 43”  
S and 15º 53’ 52” E. Etosha spans an area of 22, 915km2 of which 4 760km2 of the park is covered by a salt pan. The study site was at the Okaukuejo waterhole (19° 10' 60.00"S, 15° 55' 59.99"E), central to ENP. The waterhole is located within to the Okaukuejo rest camp. Okaukuejo is 17km from Anderson Gate in the south of ENP and is approximately 650km from the capital Windhoek. The Okaukuejo waterhole was selected as a study site because it is a floodlit, permanent waterhole and draws all types of wildlife, including elephants, lions, black rhinoceros and springboks, especially during the lengthy dry season. The waterhole is a hub for animal activity starting in the early morning hours because of the number of animals and interactions between them.



Figure 1: Namibian map showing the location of Etosha National Park





Figure 2: A map of the Etosha National Park showing the Okaukuejo waterhole. Photo credit: Google photos.

### *Climate*

The Etosha National Park has a savanna desert climate with an annual average temperature is 24ºC (Sannier, et al., 2002). During winter, the mean nighttime lows are around 10oC while summer temperatures are often around 40oC. Due to its desert-like climate, there is a large variation between day and night. The average rainfall in Etosha ranges between 250-500mm and the rainfall patterns are highly erratic and variable. Nearly 70% of the area’s rainfall occurs during the period from January to March, and this is considered to be the wettest period of the ENP. In contrast, during the winter period from July to September is the driest, with almost no rainfall (Kimaro, et al., 2015).

### *Vegetation*

In most places of the park, the Etosha pan lack vegetation with exceptions of halophytic *Sporobolus salsus*, a protein-rich grass eaten by grazers such as wildebeests and springboks. Areas around Etosha pan also have other halophytic vegetation including *Sporobolus spicatus* and *Odyssea paucinervis* as well as shrubs like *Suaeda articulate*. Most of the park is savanna woodlands except for areas close to the pan. Mopane is the most dominant tree estimated to be around 80% of all trees in the park. The sandveld of north-eastern corner of Etosha is dominated by acacia and Terminalia trees. Tamboti trees characterize the woodlands south of the sandveld. Dwarf shrub savanna occurs areas close to the pan and is home to several small shrubs including a halophytic succulent *Salsola etoshensis*. Thorn bush savanna occurs close to the pan on limestone and alkaline soils and is dominated by acacia species such as *Vachellia nebrownii, Vachellia luederitzii, Senegalia mellifera, Vachellia hebeclada* and *Vachellia tortilis* (Cunningham & Jankowitz, 2010).

### *Soil, geology and physical features*

The geologic features are more different and granite, shale, quartzites, and pyroclastic material can be found in addition to the more usual limestones and dolomites. The area south and south west of the pan is karstveld, with calcrete rubble on the surface. There is an extensive area with calcareous loamy soils on the west of the pan and to the north of the park is Aeolian Kalahari-sand type. The first two major groups of soil are probably related to shrinking of the pan, and the Aeolian sands are a more recent overburden (Amy, et al., 2011).

## *Sampling*

## Animals at the waterhole were video-recorded between sunrise and sunset during the dry season, and the focus was mainly on recording springbok in different group sizes. Animals were video recorded from the time a group arrived to the time it left the waterhole. The study was carried out from 20th-25th July (to avoid seasonal effects) for 6 consecutive days.

The vigilance of springbok in the presence of other species was noted. Vigilance was recorded as “the head above the shoulders” when springbok scanned its environment. Each mammal group was observed for not more than once a day (assuming the animal only drink water once a day). The 10×50 binoculars and a video camera was used for pre-data collection as well as the actual data collection, to observe and record the vigilance behaviour of springbok from a minimal distance of 20m-30m to minimize disturbances. Different group sizes of springbok that come to the waterhole were chosen using simple random sampling (to sample element without replacement) (Kirk, 2011) to reduce bias. Vigilance behaviour of springbok that were recorded using a video camera and 10×50 binocular were raising the head above the shoulder when they are drinking water and scanning the environment. Picked at random, different group sizes recorded for a maximum of 10minutes were each divided at an interval of 2minutes session per individual member of the group. The data collection was carried out from morning(08h00) to afternoon(17h00) at the Okaukuejo waterhole. The number of springboks per group was counted and the number of times each individual raises its head above the shoulders to scan its surroundings, as well as the number of individuals that were vigilant in each group. Any disturbance that took place during data collection around the study area was also noted as well. From the videotape, time spent by individuals being vigilant was extracted. The data collected and recorded was stored for further analysis.

## *Data analysis*

All statistical analysis was carried out using SPSS version 25. Data was tested for normality using the Shapiro –Wilk test. A spearman’s correlation analysis was used to test whether there was a correlation between group size and vigilance, total number of animals at the waterhole and vigilance, and the initial duration of head down (when the springbok first arrives at the waterhole and takes its first drink before looking up) and group size

**RESULTS**

The data was tested for normality using the Shapiro-Wilk test (test statistics= 0.7, df=3 and p-value= 0.0), indicating the data was normally distributed. The Spearman’s rho was used to test for the correlation between group size and average frequency of vigilance per individual springbok in each group. Spearman’s rho correlation revealed that there was no significant correlation between group size and vigilance behaviour of springboks (r=0.364, p=0.227).

Figure 3: The average frequency of vigilance per individual springbok in a group compared to the group size of springbok.

The highest average vigilance of seven (7) was recorded in groups of one (1) and the lowest average vigilance of two (2) was recorded in groups of thirteen (13). There was also times when the smaller groups had low average vigilance of two (2) and three (3). As the group sizes increase, average vigilance declined (figure 3.)

The average frequency of vigilance of springbok within each group size relative to the total number of animals at the waterhole is presented in Figure 4. The Spearman’s rho correlation test revealed that there was no significant correlation between the total number of mammals at the waterhole and vigilance behaviour of springboks (r=0.373, p=0.080).

Figure 4: Shows the average frequency of vigilance of springbok within each group relative to the total number of mammals at the waterhole.

Average vigilance was high when there was fewer animals at the waterhole and decrease when the total number of animals at the waterhole increased. The highest average vigilance was recorded in cases when the total number of animals at the waterhole was less than ten (10). In contrast, cases when the total number of animals at the waterhole was more than twenty (20), the highest average vigilance recorded was three. The lowest average vigilance recorded in all cases was two (2), while the highest average vigilance recorded was seven (7) when the total number of animals at the waterhole was 7.

Figure 5 presents the mean duration of head down of springbok at the waterhole in relation to the group size of springbok. The Spearman’s rho correlation test revealed that there was no significant correlation between the initial duration of head down (time spent drinking water when the springbok first arrives at the water hole) and the group size of springboks (r=0.091, p=0.680).

Figure 5: The mean duration (sec) of initial head down of springboks when they first arrive at the waterhole and take their first drink in each group of springboks at the waterhole.

The average duration of initial head down was high in smaller group size than those in larger groups. The highest average duration of initial head down of springboks in each group of about forty-nine seconds (49 sec) was recorded in a group of six (6) springboks, while the lowest average duration of initial head down of nine seconds (9 sec) was recorded in a group of 1 springbok. Groups of more than twenty-five (25) individuals had an average duration of initial head down ranging between twenty seconds (20 sec) and thirty-five seconds (35 sec).

# DISCUSSION

# *Vigilance and group size of springbok*

The statistical results shows that there is no significant association between group size and vigilance behaviour of the springboks. This could be explained by different caveats of my study. One could be because the group data was pooled and all the other factors that affect group vigilance were not accounted for. Correlation may differ as a function of another unmeasured variable (Beauchamp, 2013), such as sex, presence of the young, age, etc. such that, the expected relationship/ correlation is evident only due to certain factors (Beauchamp, 2013). Additionally, heteroscedasticity may also assume that the magnitude of the relationship between two variables may be estimated poorly (Beauchamp, 2013). Another factor that may have resulted in no correlation between group size and vigilance could be my stipulation of group size such that I may have defined group size in appropriately, because group size was measured over a small area. Often studies on large mammals use larger radius to measure group size (Marel, et al., 2019). Results of studies that investigate the influence of group size on vigilance agree upon the fact that there is a decrease in individual vigilance and an increase in collective vigilance with increasing group size (Quenettte, 1990). However, inconsistency were noticed with regards to this basic model (Quenettte, 1990). There are studies that showed an inverse relationship between group size and feeding time for springbok groups with over 30 individuals (Quenettte, 1990). Furthermore, the patterns of vigilance differed remarkably between the group sizes.

When springboks are in smaller groups, there are fewer eyes for predator detection compared to when they are in larger groups. This is called the ‘many eyes’ hypothesis which states that the more the eyes the easier it is to detect a predator and therefore, individuals in a group may decrease their own vigilance and rely upon group members for predator detection (Li & Jiang, 2008). The problem with many eyes effect is that other individuals are reliant on signal and alarm calls from vigilant individuals but this often cause chaos in when signals and alarm calls are released causing them to run towards the predator instead of running away from it. Such high level of vigilance in smaller groups can allow individuals to detect predators faster compared to individuals in larger groups who may depend on group members for predator detection.

## *Vigilance of springbok in relation to the presence of other mammals at the waterhole*

The statistical analysis showed that there was no significant correlation between the average vigilance behavior of springboks and the total number of mammals at the waterhole (figure 4). This shows that the number of mammals at the waterhole regardless of what species they belonged to did not influence the vigilance behaviour of springboks. Many animals that share the waterhole with springboks are fellow ungulates and herbivores. This can result in springboks becoming habituated to sharing the waterhole with them that they no longer elicit stimulus responses. As stated by Torres, et al., (2015), social factors, species identity and local environmental conditions all equally contribute to vigilance behaviors of animals as do the group size.

Results in figure 3 indicate that the average vigilance of springboks was higher in cases were the total number of mammals were few and declined with increase in the total number of animals present at the waterhole. Large numbers of animals at the waterhole act as a shield for springboks against springboks, hence the decline in vigilance with increasing number of animals. This is referred to as the dilution effect hypothesis, the risk of each individual in a group being attacked is reduced by increasing numbers of individuals (Wang, et al., 2015). When in smaller groups, each individual stands an equal chance of being preyed upon by a predator, which would explain the high average vigilance in springboks when the total number of animals is low. Vigilance is considered the measure of the fearfulness of predation risks and vigilant individuals increase their chance of escaping earlier from predation (Tatte, et al., 2019). The type of habitat in which the animals occur also affect vigilant behaviour of animals. Considering that the waterhole where the study was carried out was in an open area with little visual barriers, animals could spot a predator approaching from a distance thus being less vigilant because animals that are vigilant are able to see far. Species that rely upon visual aid for predator detection have shown to increase vigilance activity when there is increased obstruction to their sight (Wang, et al., 2015).

## *The duration of initial head down of springboks in each group of springboks at the waterhole*

The present study revealed that there was no statistically significant association between the duration of initial head down of springboks (sec) and the group size. This could be explained by possible errors in time recording, such that the reaction time to start or stop the video was either slow or fast. Furthermore, the time spent by springbok drinking when they first arrive at the waterhole might have been influenced by other environmental factors (i.e., that would induce vigilance behaviour, such as noise caused by the tourists visiting the waterhole). Additionally, interspecific interactions caused a reduced duration of initial head down, disturbance from members of the same group influence the duration of drinking time irrespective of the group size.

In contrast to statistical results, figure 4 shows average duration of initial head down was high in cases of smaller groups at the waterhole in total compared to larger groups. When the springboks are at the waterhole in smaller groups they are likely to spend more time drinking due to minimal disturbance by their group members. Predation pressure is another factor that influence the vigilance behaviour of animals (Wang, et al., 2015). There are hardly any lions that come to the Okaukuejo waterhole during the day, so springboks would choose to use the waterhole day-time when predation risk is low, this way they spend more time drinking and less time being vigilant even when they are in smaller groups. Effects of environmental conditions such as time of the day and the number of people at visiting the waterhole could also help explain the lengthy duration of initial head down in springboks that are in smaller group sizes. Assuming they come early in the morning when other animals are still foraging and there are a few number of people visiting the waterhole during early morning hours, the springboks are more likely to spend a long time taking their first drink. Springboks in larger groups experience too much interspecific interaction and external disturbance from visitors. There were cases were springboks experienced provocation from their group member when they start to take their first drink. There are also instances where fighting between group members caused drinking individuals to raise their heads as they start to drink.

# CONCLUSION

The current study showed no significant correlation between the vigilance behaviour of springboks and the group size. It also revealed that there was no association between vigilance and the number of mammals present at the waterhole. Furthermore, the study showed no significant correlation between mean duration of initial head down of springbok and the group size.

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