

Group size effect on vigilance: Evidence from Tibetan gazelle in Upper Buha River, Qinghai-Tibet Plateau

Zhongqiu Li, Zhigang Jiang*

Key Laboratory of Animal Ecology and Conservation Biology, Institute of Zoology, The Chinese Academy of Sciences, Graduate School of the Chinese Academy of Sciences, Beijing 100080, China

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Abstract

Tibetan gazelle *Procapra picticaudata* is a threatened and endemic species to the Qinghai-Tibet Plateau. With the method of group scan sampling, we observed the behaviours of males and females of the gazelle in the two summers of 2005 and 2006, in order to test the group size effect on group vigilance. We found that male gazelles were significantly more vigilant than the females at both group scan level (percentage of individuals scanning during a session) and group scan frequency (percentage of intervals with at least one individual scanning). We also found a negative correlation between group scan level and group size and a positive correlation between group scan frequency and group size, showing the group size effect on vigilance was testified in Tibetan gazelle. The predation factor might be the main driving force for the group size effect.

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1. Introduction

One of the many advantages of living in groups is that each member of a group spends less time to be vigilant and more time for feeding and other important behaviours (Pulliam, 1973). The negative relationships between group size and vigilance, which is called “group size effect”, have been reported in many birds and mammals (Elgar, 1989; Lima, 1995; Roberts, 1996; Dias, 2006). Three main hypotheses have been proposed to explain this inverse correlation: the ‘many-eyes’ hypothesis or the detection effect (Pulliam, 1973), the ‘safety in numbers’ hypothesis or the dilution effect (Cresswell, 1994), and the ‘scramble competition’ hypothesis (Beauchamp, 2003).

The ‘many-eyes’ hypothesis states that more eyes are easier to detect a predator, and thus individuals decrease their own vigilance and benefit from other group members (Pulliam, 1973). The ‘safety in numbers’ hypothesis proposes that the risk of being predated would be diluted in large groups because predators usually predate only on one prey during an attack (Whitfield, 2003). These two hypotheses consider that the vigilance serves the main function in detecting predators, and

therefore they are classified as the predation effect (Beauchamp, 2003, 2007). Many studies have provided evidences for the predation effect (e.g. Lima, 1995; Roberts, 1996; Whitfield, 2003). The ‘scramble competition’ hypothesis focuses mainly on that group members that compete for the limited food resources, thus leading to a decrease in vigilance with the increasing group size. Some theoretical and field studies also supported this hypothesis (Beauchamp and Ruxton, 2003; Randler, 2005a,b).

Although the group size effects occur in many birds and mammals, they are not found in black howler monkeys *Alouatta pigra* and swan geese *Anser cygnoides* (Treves et al., 2001; Randler, 2003). Therefore, studies on group size effects should be conducted in more species to explore whether and how the effects take place.

Moreover, apart from group size, sex also affects vigilance levels. Many studies have shown that the vigilance levels are usually different between males and females, although which sex is more vigilant is not consistent (Elgar, 1989; Childress and Lung, 2003; Shorrocks and Cokayne, 2005; Cameron and du Toit, 2005). For example, in impala *Aepyceros melampus* males are more vigilant (Shorrocks and Cokayne, 2005), while in merino sheep *Ovis aries* females are more vigilant (Michelena et al., 2006). Other factors, such as the nearest neighbor distance (Fernandez-Juricic et al., 2004; Randler, 2005a), the age (Boukhriss et al., 2007), the coloration of animals (Gotmark and

* Corresponding author. Tel.: +86 10 6480 7268; fax: +86 10 6480 7099.
E-mail address: jiangzg@ioz.ac.cn (Z. Jiang).

Hohlfalt, 1995), the time of daylight and season (Elgar, 1989), and the centre-edge position (Lazarus, 2003; Dias, 2006), may also play a part in the vigilance levels.

Here, we studied the vigilance behaviour of Tibetan gazelle *Procapra picticaudata* in Upper Buha River, Qinghai-Tibet Plateau during two summers of 2005 and 2006. Because of the life history traits of this endemic ungulate, we expect (1) male gazelles behave more vigilant than females and (2) vigilance level decreases with the increasing group size.

2. Materials and methods

2.1. Study areas and subjects

This study was conducted in the upper Buha River, Tianjun County, Qinghai Province, China (36°53'30"–48°39'12"N, 96°49'42"–99°41'48"E), which was located in northwest part of Qinghai Lake drainage area and south of the Qilian Mountains. Elevation ranges from 2850 m to 5826 m above sea level, with average elevation of 3800 m. The climate is characterized by dry, cold winters, strong winds, high levels of solar radiation and a short frost-free period. Mean annual temperature is -1.5°C , extreme recorded low temperature is -40°C . Annual precipitation varies from 330 mm to 412 mm, and most rain fall in between June and September. Alpine meadow is the main vegetation in the core study area of about 200 km². The dominant plants are *Kobresia* spp. and *Stipa* spp. The Buha River is the largest river flows into the Qinghai Lake, the largest semi-salty lake in China.

Our study subject was Tibetan gazelle, a threatened and endemic species to the Qinghai-Tibet Plateau (Jiang, 2004). The populations of Tibetan gazelle are decreasing sharply and their ranges are fragmented and rapidly shrinking (Schaller, 1998; Zhang and Jiang, 2006). Accordingly, it is now classified as a Category II Protected Wild Animal Species in China and is listed as Low Risk in the IUCN Red List of Threatened Species (Zhang and Jiang, 2006). Tibetan gazelle is sexually dimorphic. Body length of the gazelle is short than 1 m, body weights are less than 20 kg (Zheng, 1994). The mixed-sex groups are mainly found during the rutting season from late December to early January and after then they separate and aggregate in single sex groups (Lian et al., 2004). The lambing period of Tibetan gazelle is about 2 weeks, from late July to early August (Li and Jiang, 2006). Tibetan gazelle is a common wild ungulate in the study area. The focal population at the south of Buha River consists of about 100 individuals. Main predator is wolf, there were about 10 wolves in this area.

2.2. Behavioural observation

Behaviours of Tibetan gazelle were observed with group scan sampling method (Martin and Bateson, 1993) from June to September 2005, and from June to July 2006. As Tibetan gazelle is inactive during night, observations were usually recorded during the daylight between 07:00 and 20:00. Because it was difficult to identify the individuals in the wild, we observed

randomly selected groups with a binoculars (8 × 42) and a (20–60 × 63) telescope.

The activities (feeding, bedding, moving, standing and others) of all the group members were instantaneously recorded with scan sampling method at 5-min intervals. Behaviours were classified into five categories: feeding and searching ("feeding" in the following text), bedding and ruminating ("bedding" in the following text), moving, standing and other behaviours. Feeding was defined as a gazelle grazing on the pasture or moving during a grazing bout with its head below its vertebral column. Bedding referred to a gazelle sitting on the ground for rest and rumination. Moving consisted in a gazelle walking or running with its head above its vertebral column. Scanning referred to a gazelle standing and scanning its surroundings or being motionless with its head up, and sometimes the gazelle regurgitates and masticates a cud. Other behaviours included grooming, defecating, lactating and nursing a lamb.

We used "scanning" behaviour as our estimate of vigilance because (1) the head-up posture brings all the sensory organs to a position that should increase the detection range, (2) it costs time that could be used in other activities, and (3) it is the observed state of alertness when a predator is detected (Childress and Lung, 2003). Group vigilance was estimated with group scan level and frequency. Group scan level was calculated as the percentage of individuals in the group engaged in scanning during the session. Group scan frequency was estimated as the percentage of intervals where at least one gazelle was scanning.

One session was defined as an observation started when a male/female group of Tibetan gazelle was found until the group size changed. The observation time ranged from 20 min to 275 min with a median of 70 min. We attempted to observe the gazelle over all daylight hours equally, in order to minimize the effect of daytime hours on vigilance. The nearest neighbor distance in the gazelle groups was usually stable, ranging from 3 m to 5 m. The observed groups ranged from 1 to 15 individuals. Sessions shorter than 30 min were discarded. Because only six mixed-sex groups were found and they usually separated before the observations reached 60 min, these sessions were also discarded. All behaviours were observed by the same person. A total of 155 behavioural sessions were observed, of them, 72 (5085 min) on female groups, 73 (4980 min) on male groups.

2.3. Data analysis

Data were analyzed with SPSS 13.0 statistical package. The data of the group scan level (defined as the percentage of individuals scanning during a session) and the group scan frequency (defined as the percentage of intervals with at least one individual scanning) were firstly arcsine square-root transformed and then were tested with one-sample Kolmogorov–Smirnov test for normality. All data were normally distributed, and then the General Linear Model was used to test the sexual difference and group size effect. All significant differences were set at $P=0.05$. In the analysis, we entered sex, group size and their interaction as explanatory variables, but found the interaction was not significant. So we removed the interaction of sex and group size and reanalyzed the data.

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