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Activity, movements, and sociality of newborn Mongolian gazelle calves in the Eastern Steppe

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We hand-captured, fitted with motion-sensitive VHF transmitters, and monitored 19 newborn (1–2 days old) Mongolian gazelle *Procapra gutturosa* Pallas, 1777 calves in Dornod, Mongolia during the 2000 and 2003 calving seasons to identify changes in activity, movements, and sociality with age. Overall, activity was highly variable throughout the day, regardless of age or year. Calf activity increased, however, from day 2 (age = 2 days; 18% total activity) to day 7 (29%), and 3-fold by day 25 (54%). By days 5–8, calves had moved an average of 6.6 km (range: 2–21 km) from capture sites but were still only seen alone or with their mother. By day 24–26, however, they were located an average of 41 km (range: 24–63 km) away from their capture site, and most (7 of 9) were in aggregations of >1000 animals. Mongolian gazelles do not display behaviour associated with "hiders" after about 2–3 weeks. This reflects the wide-ranging, nomadic existence of the species.

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Introduction

Many migrating ungulates have synchronized birthing periods and are noticeably more sedentary when calving. Ungulate species, in general, fall into one of two categories with regard to the type of mother-infant relationship occurring post-partum; "follower" calves accompany their mothers from the time they first gain their feet, while "hider" calves go through a lying-out stage and are separated from their mothers except during nursing and care sessions that might occur only 2 or 3 times per day (Lent 1974, Estes 1991). The "hiders" remain in hiding for about the first ten days of life, then following

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their mothers (Bannikov 1954, Lushchekina *et al*. 1986). This behaviour, like that for "followers", is widely interpreted as providing antipredator related benefits (eg Fitzgibbon 1990). Although these neonate behaviours are well accepted for many different species, quantitative data concerning levels of 24-h activity, movements, and sociality of neonates as they transition from newborns to month-old calves able to keep up with traveling adults is important for every species of ungulates (cf. Schaller *et al*. 2006).

Mongolian gazelles *Procapra gutturosa* Pallas, 1777 are considered nomadic migrants in constant search of suitable pasture (Sokolov and Lushchekina 1997, Mueller *et al*. 2007), but also have synchronized birthing periods and are sedentary when calving (Olson *et al*. 2005*a*). Mongolian gazelle calves more closely resemble the "hider" type of mother-infant relationship (Sokolov and Lushchekina 1997), and, indeed, gazelle calves have a relatively low predation rate (0.02) during the first 10 days of life (Olson *et al.* 2005a). General daytime observations have indicated that very young gazelles can run considerable distances and after a week or two "leave their bedding places and slowly migrate to other steppe localities" (Sokolov and Lushchekina 1997). We quantitatively investigated 24-hour activity, movements, and sociality for newborn Mongolian gazelle calves in the Eastern Steppe of Mongolia to gain insights into newborn calf behaviour. Specifically, we documented when calves transitioned to traveling with their mothers, moved away from calving areas, and socialized with other adults. This has implications with respect to predator avoidance strategies and potential effects of disurbance by increasing human activities.

Study areas

Mongolia's Eastern Steppe, the largest intact temperate grassland in the world, covers approximately 250 000 km^2 (Olson *et al*. 2005b). Calf capture sites were near "Ekhen Khudag" (47°20'N, 114°30'E) in 2000 and in the western part of "Toson Khulstai" Natural Reserve (47°50'N, 113°50'E) in 2003. Both sites are in Dornod Province and consist of flat plains and rolling hills that are 600–1100 m a.s.l. The climate is semi-arid and continental, with long cold winters and short summers. During late June and early July (when calves were first being monitored), the average maximum temperature is about 29°C and the average minimum is about 15°C. Warm season precipitation mainly occurs during July and August and overall precipitation is generally between 200–300 mm/year (Gunin *et al*. 2000).

Dominant soil types are characterized as sandy loamy chestnut soils with localized sites of highly salinized soil (Gunin *et al*. 2000). Steppe vegetation is dominated by grasses (*Stipa* spp., *Cleistogenes* spp., *Leymus* spp.), forbs, (*Artemisia* spp., *Allium* spp., *Astragulus* spp.), and *Carex* spp. sedges (Gunin *et al*. 2000). A few shrubs (*Caragana* spp., and *Prunus* spp.) are present and trees (*Ulmus* spp.) are extremely rare. Onset of green-up occurs from late May to early June (Lee *et al*. 2002, Yu *et al*. 2003).

Potential predators of gazelle calves are wolves *Canis lupus*, red *Vulpes vulpes* and corsac foxes *V. corsac*, Pallas' cats *Felis manul*, and raptors such as steppe *Aquila rapax* and golden eagles *A. chrysaetos*, upland buzzards (*Buteo hemilasius*), and cinereous vultures *Aegypius monachus* (Sokolov and Lushchekina 1997, Olson *et al*. 2005a). Takhi *Equus przewalski*, and khulan *Equus hemionus* have been extirpated from the system and currently there are no other wild ungulates in the system, with the exception of black-tailed gazelles *Gazella subgutturosa* occupying the desert steppe fringes. Common alternate wild prey species are Siberian marmots *Marmota sibirica* and Brandt's vole *Lasiopodomys brandtii* (Mallon 1985).

Nomadic pastoralists live throughout the region (0.7/km^2), and tend horse, goats, sheep, cattle, and domesticated bactrian camels (Milner-Gulland and Lhagvasuren 1998). Mongolian gazelles are hunted for subsistence use and have been commercially harvested for most of the previous 70 years (Reading *et al*. 1998) until a recent (1999) moratorium. Illegal hunting of gazelles from vehicles is common, and in much of the steppe gazelles flee from vehicles that approach within 1 km (Olson *et al*. 2005b). Wolves are heavily hunted at all times of the year, and believed to be many fewer than could be supported by the gazelle population. Significant oil reserves have been discovered in the eastern regions of Dornod Aimag (Penttila 1994), and the ecological integrity of the region is under significant threat from development interests (Asian Development Bank 2002).

Material and methods

Capture and monitoring

We hand-captured neonate (1–2 days old) gazelles (cf Franklin and Johnson 1994, Byers 1997a) by first locating calving grounds (herds of sedentary pregnant females); nearly all females gave birth during a 10-day interval (24 June – 3 July) each year (Olson *et al*. 2005*a*). During the calving interval, we searched for recumbent calves by quietly walking through an area. When a calf was spotted, one person would approach from behind with 0.8-m diameter handheld hoop net while another stood in front to distract it. The net was quickly placed over the resting calf, which was then immediately removed and calmed by placing a cloth hood over its head. We used surgical gloves when possible and kept radio collars in bags filled with *Artemisia frigida* leaves to minimize the potential for fawn abandonment by mothers due to human scent. Calves were weighed in a bag, their sex was determined, and each was fitted with motion-sensing (2-to 4-hour delay; cf Beier and McCullough 1988) expandable radio-transmitter (65 g; Advanced Telemetry Systems, Isanti, MN, USA; cf Smith *et al*. 1998) that had a battery life of 13 months. We estimated calf age (< 1 day vs < 2 days old) from calf behaviour when we approached (sleeping, alert; calves "run quickly a day or two postpartum"; Sokolov and Lushchekina 1997), its response to being handled (remained calm, or struggled), dryness of pelage, (wet, damp, dry) and condition of the umbilical chord (bloody, dry at tip, completely dry) (cf Galli *et al*. 2008). Once data collection was completed (mean handling time was about 90 s), calves were placed in their original hiding spots and observers moved away slowly. The protocol for capturing and marking gazelles was reviewed and approved by the University of Massachusetts at Amherst Institutional Animal Care and Use Committee.

Once all calves were marked, each was monitored, via a radio receiver with headset and ground-based 4-element yagi antenna on a 4.5-m long pole, from distant hilltops to increase signal reception distance and to avoid disturbing the natural behaviour of the gazelles. In 2000, the team tried to monitor each collared individual for activity at 15-min intervals, 24 hours/day for the first 10 days after capture, recognizing that activities on the day of capture might be compromised. In 2003, we monitored calves similarly on the 2nd, 3rd, 5th, 7th, 10th, 13th, 18th and 25th days of their life. Radio signals were categorized as active (an erratic series of pulses) or inactive (a steady pulse) based on signals heard during the first 10–20 seconds of listening (cf. Kenward 2000), but recognize that some standing calves might send "inactive" signals, and that "active" signals represent some kind of substantial movement. During 22 June – 16 July 2000, calves were located by triangulation during inactive periods (mid-day) about once every 3 days. Because of the distance between monitoring sites and some animals, topographical barriers, and the signal-receiving capacity of the receiver antenna, some calves could not be monitored on a given monitoring attempt. We also tried to observe gazelle herds to identify when calves started regularly traveling with their mothers. This was sometimes difficult because in this region, as noted above, the gazelles are extremely wary of automobiles. Finally, some calf mortality occurred within the first 10 days of life ($\bar{x}$ = 16% over 4 years, with only 2% due to predation and the rest due to abandonment, hypothermia or unknown causes; Olson *et al*. 2005a), further reducing our sample size. Thus, we collected activity, movement and sociality data for as many as 10 radio-marked calves (4M:6F) in 2000 and 9 (5M:4F) in 2003. Of these, 5–6 were monitored on any of 7 consecutive days (2 to 8 days old) during 26 June to 3 July 2000 (n = 3,799 activity recordings), and 2–5 calves were monitored for any of 8 days (2 to 25 days old) during 4 July to 28 July 2003 (n = 3,072 activity recordings).

Data analyses

Extensive statistical analyses were limited by sample sizes and variation in collected data. For an individual gazelle, data collected at 1–4 possible 15-min intervals in each hour (minutes 1–15, 16–30, 31–45, and 46–59) were pooled to derive consecutive hourly estimates of activity for a given daily age (eg, 2 active and 2 inactive signals during the hour resulted in 50% activity). These hourly estimates were averaged for each sex for a given day and compared (cf. Jackson *et al*. 1972, Mathisen *et al*. 2003). Because we identified no differences between sexes (t-tests; $p > 0.20$), data were then pooled and averaged for the 24 hours of each day to obtain a daily activity total. To look at changes occurring through the day, we plotted hourly averages, and also averaged estimates for each hour for each of four consecutive daily time periods: Day (05:00–19:59 h), Dusk (20:00–20:59 h; centered on sunset), Night (21:00–03:59 h), and Dawn (04:00–04:59 h; centered on sunrise). To identify time periods when mobility and sociability increased, we calculated and compared (via regression analyses) the mean distances between individuals' capture site and subsequent locations (pooled 1- to 4-day periods), and the distribution of group sizes that calves were in, as related to age (pooled 3- to 4-day periods; χ^2 tests).

Results

Newborn calves were active throughout the day, and by day 7 appeared to have relatively higher activity levels near dusk and dawn (Fig. 1); point estimates of calf activity at dusk were usually (11 of 15 days) higher than at other times. Overall, calf activity increased ($R^2 = 0.64$, 9 df, $p = 0.003$) from day 2 (age = 2 days; 18% total activity) to day 7 (29%), and 3-fold by day 25 (54%; Figs 1, 2). By days 5–8, calves had moved an average of 6.6 km (range: 2–21 km) from capture sites (Table 1) but were still only seen alone or with their mother (Table 2). By day 24–26, however, they were located an average of 41 km (range: 24–63 km) away from their capture site, a significant increase over time ($R^2 = 0.97$, df = 6, $p < 0.001$), and most (7 of 9) were in aggregations of > 1000 animals ($\chi^2 = 42.6$, df = 18, $p < 0.001$). Mongolian gazelles do not display behaviour associated with "hiders" after about 2–3 weeks, based on distances moved from birth sites (8–63 km) and group of herd sizes (71–90% in groups > 100).

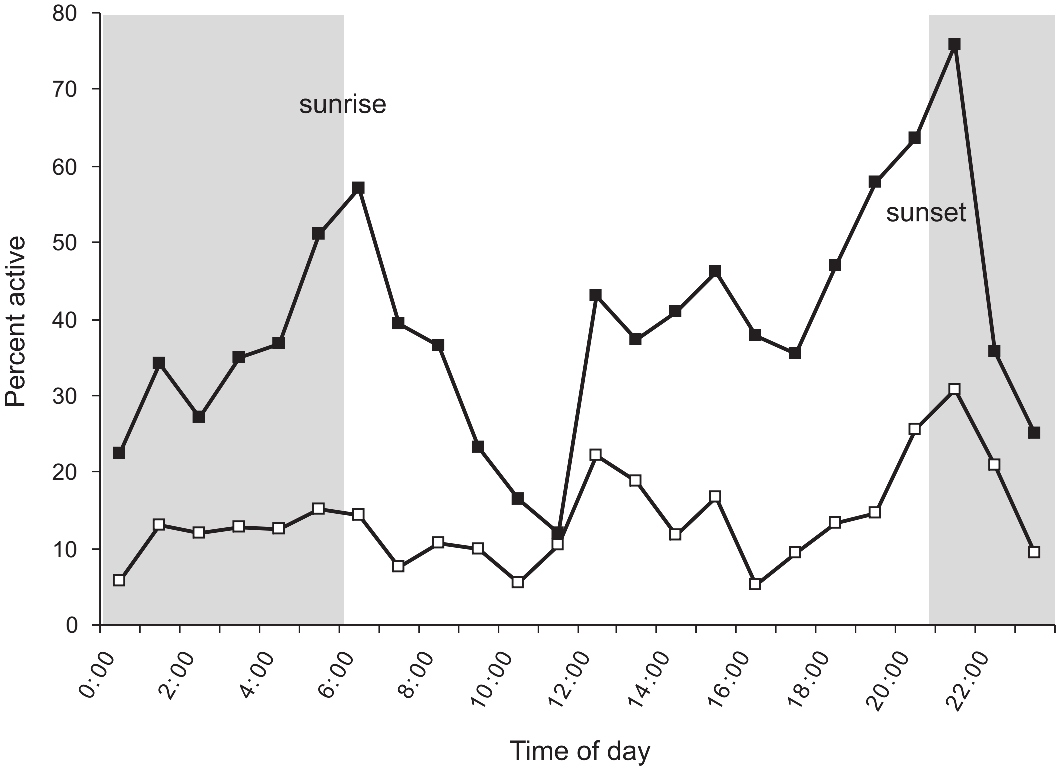

Fig. 1. Mean hourly activity levels of 2-day-old (open squares) and 7-day-old (solid squares) Mongolian gazelle calves radio-monitored during 2000 and 2003 in the Eastern Steppe of Mongolia.

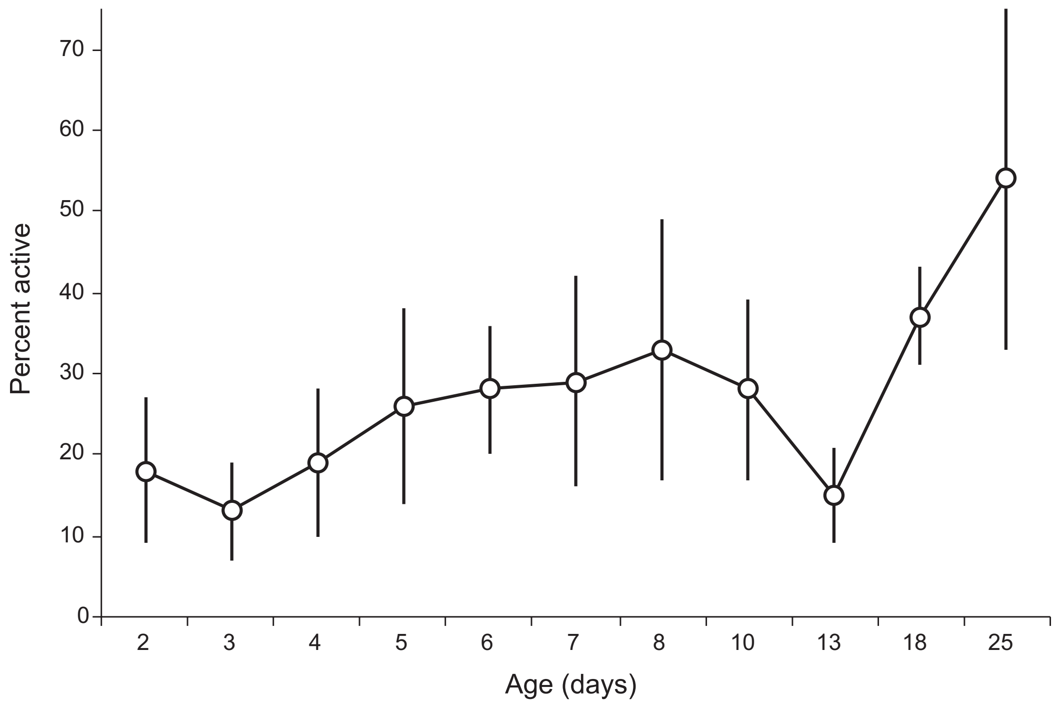

Fig. 2. Variation in diel activity (mean percent time active ± SD, years pooled) of radio-marked newborn Mongolian gazelle calves monitored in Dornod, Mongolia during 26 June to 2 July 2000 and 2–28 July 2003.

Table 1. The distance (km) that 10 newly born radio-marked Mongolian gazelle calves were located from their birth site during 22 June – 16 July 2000.

Age (days)	No. of distances	Mean	Range
2	3	1.9	1.4–2.4
3–4	6	6.1	1.4–11.6
5–8	9	6.6	2.3–21
9–12	19	11.8	1.8–32
13–15	17	24.6	3.7–94
16–19	19	26.9	3.8–94
20–23	17	30.5	8–48
24–26	10	40.8	24–63

Table 2. Percent of 10 newly born radio-marked Mongolian gazelle calves located in groups or herds of various sizes during 22 June – 16 July 2000.

Age (days)	No. of observations	Group size			
		1	2–100	101–1000	1000–10 000
2–4	9	100			
5–8	9	100			
9–12	19	63	11	26	
13–15	17	35	18	24	24
16–19	19	68		16	16
20–23	17	24	6	47	24
24–26	10	10		20	70

Discussion

Mongolian gazelles, after beginning life fairly cryptically, are regularly active throughout the day and night, and soon are moving significant distances and integrating with numerous conspecifics. Other ungulate species for which activity observations have been more detailed appear to nurse 2 to 10 times per day (Lent 1974) and levels of activity throughout the day have been described as polyphasic, sometimes with definable diel patterns, that change with time (eg Jacobsen 1984). Amount of daily activity increases with age, as we found, but varies among species with respect to amounts of activity at particular ages (Jacobsen 1984, Byers 1997b). For example, week-old white-tailed deer *Odocoileus virginianus* fawns spent 8% of their time active during 24 hours and they were active for 10–30 minutes once or twice a day (Jackson *et al*. 1972). Also, newborn Tibetan antelope *Pantholops hodgsoni* calves were active 15–45% of the time during their first week of life (Schaller *et al*. 2006). Activity of Mongolian gazelle calves is relatively high, and correlated with the distances they move early in life.

In addition, it is clear that the length of time that ungulate calves or fawns maintain the hiding phase varies (from several days to several months) by species (Lent 1974, Reif and Klingel 1991, Thompson 1998, Schaller *et al*. 2006). This interval for Mongolian gazelles is somewhat short in the continuum for gazelles and antelope (Lent 1974). In some species, such as white-tailed deer, neonates remain in small home ranges (0.4 km^2) during the first 2 months of life (Hiller *et al*. 2008). It is not surprising that gazelle calves moved far from birth sites within a matter of weeks; the species ranging patterns are such that annual home ranges of calves vary from 800–18 000 km^2 (Olson 2008).

The ability to move quickly, over large distances, and with many conspecifics may also be related to anti-predator behaviour. Even though predation mortality is low during the first 10 days of life, calving aggregations in the thousands undoubtable draw in predators looking for an easy kill. Thus, the calf behaviours we documented may serve to offset such pressure. A related concern is the potential effects of humans on calf survival. Though we did not conduct specific “disturbance” experiments related to calf behaviour, it is conceiveable that ill-timed activities of hunters, oil field workers, or even tourists might ultimately affect gazelle calf survival, especially if it increased activity and movements of hiders which count on inactivity to minimize predation levels (Estes 1991). For Mongolian gazelles, oil development, in particular, seems to greatly influence their distribution (Olson *et al*. 2009). We think it is reasonable to suggest that human activities near areas where Mongolian gazelles are calving should be minimized during their first few weeks of life.

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