Lunar Condition Influences Coyote (Canis latrans) Howling

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ABSTRACT.—Prairie folklore suggests that coyotes (*Canis latrans*) increase howling when the moon is full, yet menstrual patterns of coyote vocalizations have never been formally investigated. Thus, our purpose was to determine whether howling by coyotes is related to lunar condition. The study was conducted in July and August 1992, and from June to August 1994, in the Cypress Hills region of southwestern Saskatchewan, Canada. Coyote howling was surveyed immediately following dusk for 90–120 min, and was categorized by lunar condition. Group howling and group-yip howling were negatively related to increasing moonlight, but there was no relationship between lone howling and moonlight. These results might be explained by changes in the social behavior of coyotes with respect to foraging behavior and territory defense.

INTRODUCTION

Coyotes are known to exhibit diel and seasonal variation in vocalization rates (Laundre, 1981; Walsh and Inglis, 1989). Monthly, or more appropriately, menstrual, variation is poorly documented, although prairie folklore suggests that coyotes (*Canis latrans*) increase howling activity when the moon is full (note the term menstrual refers to the period of the lunar cycle, which is approximately 29.5 days, whereas the term monthly implies a period of 28, 30, or 31 days). However, to the best of our knowledge this suggestion has never been formally investigated. Coyotes tend to be most active during the night, especially around dusk and dawn (Andelt and Gipson, 1979). In addition, coyotes rely heavily on visual cues for navigation and hunting (Horn and Lehner, 1975; Wells and Lehner, 1978). Therefore, it is reasonable to predict that night-time ambient light conditions, namely moonlight, may significantly affect coyote behavior.

Coyote howling can be categorized into at least three distinct vocalizations. These include lone, group, and group-yip howling (Lehner, 1978a, b). According to Lehner, the lone howl is given by a single coyote and is of high amplitude and long duration. This is the typical long-distance vocalization attributed to the coyote. Its purpose is likely to communicate the location of individuals separated from the pack. The group howl is essentially two or more lone howls given simultaneously by individuals at the same location, and the group-yip howl is a high intensity vocalization with several individuals howling and yipping together in seemingly distinct patterns. Group howls and group-yip howls appear to be important for advertising territory, thereby preventing violent contact between groups of coyotes, and may be used to coordinate group hunting (Lehner, 1978a, b).

The purpose of this study was to test the prediction that howling activity by coyotes is related to lunar condition. If so, moonlight may be important in determining behavioral patterns of coyotes. This relationship has not been well-studied in mammalian predators, although it has been demonstrated for owls (Price *et al.*, 1984; Kotler *et al.*, 1991) and for nocturnal insectivorous birds (Mills, 1986; Brigham and Barclay, 1992) which presumably suffer from visual detection constraints when moonlight is reduced. Howling may also indicate menstrual changes in coyote activity, assuming that patterns in coyote vocalizations reflect underlying behavioral patterns (*e.g.*, changes in foraging or territorial defense).

METHODS

This study was conducted from 1 July to 31 August 1992 and 1 June to 23 August 1994 in the W block of Cypress Hills Provincial Park (49°34′N, 109°′53′W), which is approximately 65 km SW of Maple Creek, Saskatchewan, Canada. The Cypress Hills region is a bisected upland plateau that supports forests of lodgepole pine (*Pinus contorta*), white spruce (*Picea glauca*) and trembling aspen (*Populus tremuloides*). It is intermixed within mixed and fescue prairie grassland (Sauchyn, 1993). In each year, we chose three different sites from which coyotes could be heard. Sites were at least 6 km apart to minimize the likelihood of resampling the same individuals at different sites. We surveyed howling from one site per night, and sites were visited in random order. Surveys were conducted on 29 nights in 1992 and 46 nights in 1994, spanning more than five complete lunar cycles. Each night of sampling began immediately following dusk, which was defined as the time when the sun was >12° below the

horizon. At this time, solar illumination is negligible (Austin *et al.*, 1976) and moonlight, if present, is the dominant ambient light source. We grouped nightly howling into four different categories representing the 7 days around the dominant lunar phase. Each period included the 3 days preceding and 3 days following the night of the new, first quarter, full or last quarter moon. We used percent moonface illuminated (%MFI), which describes the amount of the lunar disk that is visible on any given night, as an index of the intensity of lunar illumination (*see* Mills, 1986; Brigham and Barclay, 1992). Information about solar and lunar conditions was taken from astronomical tables calculated for the study site by the Dominion Astrophysical Observatory (Victoria, British Columbia).

Each howling bout that we heard was categorized as a lone howl, group howl, or group-yip howl (1994 only; *see* below). Lone howls were defined as a singular bout when one coyote was heard to be howling without a break exceeding 10 sec. Group howls were defined as two or more simultaneous lone howling bouts given from the same location. Group-yip howls were distinguished from group howls if a cacophony of yipping and howling was heard. Group-yip howls occurred in both seasons, but were only recorded in 1994. We determined the duration of each bout by noting the start and end times of howling, measured to the nearest second. To ensure that our ability to hear the coyotes was consistent between nights, we did not sample on nights when it was raining or when wind speed exceeded 5 km/h. In addition, we did not sample on nights when cloud cover exceeded 15% of the visible sky because cloud cover diminishes available moonlight. Each sampling period lasted for approximately 90–120 min. Before analysis, nightly totals of howling activity were standardized to seconds of activity per 100 min.

RESULTS

We recorded howling on 56 of the 75 nights surveyed. Nights with no recorded howling are problematic because we were unable to determine whether coyotes were silent or simply absent. A chi-square, goodness-of-fit test ($\chi^2 = 2.16$, df = 3, $P > .05$) indicated that nights with no howling were not dependent upon lunar condition, and therefore, we removed these nights from subsequent analysis. A modified Kruskal-Wallis test (Zar, 1984) was used to determine whether howling activity differed among lunar phases. There was no significant relationship between lunar phase and lone howling ($H = 0.72$, df = 3, n = 56 nights, $P > 0.05$; Fig. 1a). However, howling did differ significantly between lunar phases for group and group-yip howls, with the greatest amount of howling occurring during the new moon period ($H = 12.73$ and 11.45, respectively, df = 3, n = 56 and 38, respectively, $P < 0.01$; Fig. 1b, 1c). Further, Spearman-rank correlations between howling activity and %MFI were highly significant for group and group-yip howls ($r_s = -0.51$ and -0.61, respectively, N = 56 and 38, $P < 0.01$), suggesting that there is a negative relationship between the amount of moonlight and the amount of howling.

DISCUSSION

Although lone howling did not vary with moonlight, group and group-yip howling were significantly related to lunar condition. However, contrary to popular folklore, our data indicate that coyotes do not howl more during the full moon period. Rather, the greatest amount of group and group-yip howling coincides with periods of least moonlight, particularly during a new moon. This relationship is interesting because it suggests that other behaviors may be influenced by moonlight. For instance, group and group-yip howling are a means of territorial advertisement (Lehner, 1978a, b), and an increase in these howls implies increased territorial defense. Messier and Barrette (1982) argued that one reason coyotes defend territories is to defend food during times of shortage. We submit that small mammals a principal component of the coyote's diet (Bekoff and Wells, 1986; Reichel, 1991), are harder to detect visually on nights with little moonlight. Although it has been shown that small mammals often are most active on moonless nights (*e.g.*, Price *et al.*, 1984; Alkon and Saltz, 1988; Kotler *et al.*, 1991, 1994; Halle, 1995), when these prey are not detectable they are not available as a food item. A decrease in available prey has been shown to increase trespassing into territories by other packs and solitary coyotes (Bekoff and Wells, 1986). Thus, increased group and group-yip howling during periods of low moonlight may be in response to the increased threat of trespassing. If a given territory has more available prey items than other areas, increased howling may be used to help defend a territory and maintain pack foraging success.

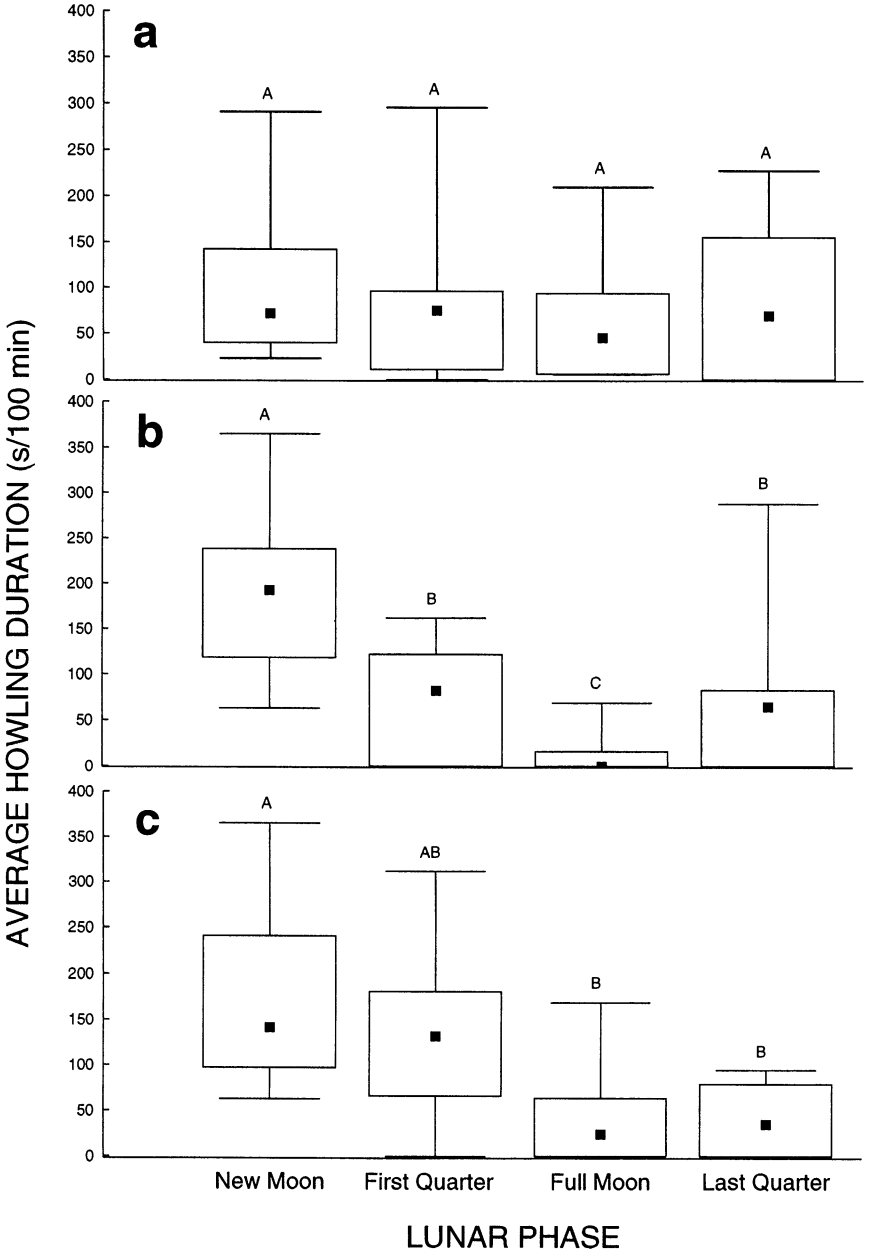

FIG. 1.—Standardized median values of nightly coyote howling duration (s/100 min) over four lunar periods for three types of howling: (a) lone howling; (b) group howling, and (c) group-yip howling. Lunar period is defined as the period including 3 days before and 3 after the night of the dominant lunar phase (*i.e.*, new moon, first quarter, full moon, and last quarter). Filled black squares indicate the median, rectangular open boxes indicate the 25% and 75% quartiles and whiskers indicate the range of data. Unique letters above boxes indicate significant differences between median values (Dunn's test, $\alpha = 0.05$).

A second scenario that may explain the relationship between howling and moonlight is that coyotes preferentially hunt larger prey on nights when vision is impaired by low levels of moonlight. It is believed that larger groups of coyotes are needed to hunt larger prey (Bekoff and Wells, 1980; Gese *et al.*, 1988). Therefore, the increase in group and group-yip howls that we observed may be an indication that a greater number of reunifications were occurring to facilitate group hunting during periods of reduced moonlight.

We conclude that lunar condition is important in determining behavioral patterns in coyotes. A menstrual pattern of howling implies that other behaviors, such as territorial defense or foraging behaviors, may also be dependent upon moonlight. We also note that seasonal responses to moonlight have been reported in other species of mammals (Lockard and Owings, 1974; Alkon and Saltz, 1988). We do not know whether the patterns of vocalizations we observed are typical of seasons other than summer. Further research is warranted to determine the extent of these relationships.

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