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Note

Key observations of flexed-leg urination in the free-ranging Gray Wolf (*Canis lupus*)

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Abstract

Flexed-leg urination (FLU) in female Gray Wolves (*Canis lupus*) has been little studied in the wild. Captive females in packs do not exhibit FLU unless they are both mature and dominant to an associate female, but these characteristics have not been confirmed in free-ranging wolves. We present observations of wolves in Yellowstone National Park that accord with those of wolves in captivity, extend our knowledge of FLU in Gray Wolf, pose additional questions about it, and suggest new areas of study to better understand it.

Key words: Behaviour; *Canis lupus*; flexed-leg urination; FLU; Gray Wolf; pair bonding; scent-marking; territoriality; Yellowstone

Scent-marking is pervasive in the Canidae (Kleiman 1966) and information about its functions and contexts has been accumulating gradually (Peters and Mech 1975). However, little is known about flexed-leg urination (FLU) in female Gray Wolves (*Canis lupus*) except that dominant, mature females paired with males exhibit it. FLU is similar to raised-leg urination (RLU) in males, but the hind leg is not lifted as high; the female is still in a partial squat with knees bent and the leg that is off the ground is only slightly out to the side or even angled forward. RLU is presumed to be used to aim urine above the ground onto prominent objects, such as stumps, snowbanks, etc., and FLU might also function to aim urine similarly, to whatever extent the female anatomy allows. Such directed urination in both sexes has long been explained as territory marking and pair-bonding behaviour as opposed to male standing urination and female squat urination (SQU), which are thought to be used for elimination (Harrington and Asa 2003). Double-marking, i.e., RLU by a male accompanied by FLU by a female, is thought to indicate a bond between a mated pair (Rothman and Mech 1979).

However, some aspects of FLU do not accord with the view that its only functions are territory marking and pair-bonding: FLU is not practised by immature female wolves nor subordinate, mature female wolves, at least in captivity (Asa *et al*. 1990). Also, even at empty food caches, only mature, dominant females use FLU (Harrington 1981). If marking served only to signal possession of territory or mate, why wouldn't any female use FLU? Even very young pups are highly possessive, cache food (Packard 2003), and defend it (Mech *et al.* 1999). Thus, much more information about wolf FLU is necessary to better understand its etiology and function. Here we describe observations of FLU in a free-ranging wolf pack and extend the findings of Asa *et al*. (1990) that, in captive wolf packs, only females that were both mature and dominant or vying for dominance displayed FLU.

From 16 May 2000 to 29 September 2001, R.M. made these observations of the Druid Peak Pack in Yellowstone National Park. At 27 wolves, this was the largest pack in the park and included four females that bred in 2000 and 21 pups. This pack was unusual, as most wolf packs include a single breeding pair and their offspring of one or two years (Mech and Boitani 2003). Several members of the Druid Peak Pack were radio-collared (Smith *et al.* 2015). They and their packmates were also located and observed from the ground using binoculars and a 60× spotting scope

during daylight. Each wolf was individually identifiable by a combination of radio frequency and/or natural body markings. During early 2000, the pack consisted of the dominant pair (male 21 and female 40 [at least 6-years old]), female 42 (40's same-aged sister), 3-year-old females (103, 105, and 106), and a 2-year-old male (163; McIntyre 2020). The Druid Peak Pack was observed during 442 days of the 494-day study; R.M. tape-recorded his descriptions as he made them and transcribed his records into a computer the same day.

Until early May 2000, the only scent-marking R.M. had observed by the members of this pack were RLU by wolf 21 and FLU by wolf 40, although wolves could have marked differently during the night when observations were not made. On 8 May 2000, wolf 40 was killed, apparently by wolf 42 and other pack members (McIntyre 2020). The first time FLU was observed in wolf 42 was on 16 May when she marked a bush, followed by RLU at the same location by wolf 21. Subsequently, wolf 42 was observed using FLU regularly, often followed by wolf 21 using RLU to double mark locations.

None of the other females were observed using FLU until almost a year later, even though wolves 105 and 106 had, along with 40, also denned and produced pups in 2000 (McIntyre 2020). On 9 April 2001, when 4 years old, 106 was first seen using FLU, just before pinning her same-aged sister, wolf 103. Notably, wolf 42 was still the dominant female in the pack at that time, although she was not with 106 when the latter was observed exhibiting FLU.

On 29 September 2001, an outsider male that male 21 allowed to join the pack was travelling together with 4-year-old female 105. When he did RLU, she sniffed the site and did FLU there, which was the first time wolf 105 was observed to use FLU, even though she was dominant to 103. Later, the new male did RLU, and 105 sniffed the site, scratched the ground, and did a momentary SQU that appeared to be scent-marking rather than urination strictly for elimination. The male then did RLU, and 105 did FLU at his site.

The 16 May 2000 observation of FLU by wolf 42 confirms Asa *et al*.'s (1990) finding in captive wolf packs that females do not exhibit FLU unless they are dominant to an associated female. This is significant, as it is the first confirmation that Asa *et al.*'s conclusion applies to free-ranging wolves and was not an artifact of captivity. The 9 April 2001 observation of wolf 106 is similarly supportive, but adds the new element that although 106 was dominant to 103 in that setting, 106 was not the highest-ranking female in the pack.

The observations that 3-year-old subordinate females did not use FLU despite being mature enough to have produced pups in 2000 further support the results of Asa *et al*. (1990). These observations also raise the question of the function of FLU. Apparently, FLU, which is usually one component of double marking by mated pairs, was not necessary to allow those females to pair long enough with males to breed. Alternately, the 3-year-old females that produced offspring might have double-marked when first paired but ceased using a FLU later.

The 29 September 2001 observation of 105 contrasts with those of Asa *et al*. (1990), because 105 was dominant to female 103, yet still did not use FLU until she met a male that used RLU. This observation introduces another element into the question of what factors are necessary and sufficient to elicit FLU. In this case, the trigger seems to have been the RLU of a potential mate. Whatever is common between gaining dominant status and being presented with a potential mate is unclear from a social perspective. Even the physiological link between gaining dominance and using FLU is obscure, given that there appears to be no difference in estradiol secretion between females that exhibit FLU and those that do not, although they do differ in testosterone level (Asa *et al*. 1990).

Although all factors required for FLU in wolves are not necessarily known, our observations combined with those of Asa *et al.* (1990) indicate that at least sexual maturity and either dominance or the presence of a male using RLU are the minimum necessary conditions. This work raises other questions. For example, are there links between genetic relatedness, dominance, and FLU patterns? Are females that display FLU reproductively more successful than those that do not? Is there seasonal variation (breeding versus non-breeding season) or spatial variation (territory edges, trails, carcasses, common-scent posts) in urination patterns? Our observations extend knowledge of FLU in Gray Wolves, pose additional questions about it, and suggest new areas of study to better understand it.

Author Contributions

Writing – Original Draft: L.D.M. and R.M.; Writing – Review & Editing: L.D.M. and R.M.; Conceptualization: L.D.M.; Investigation: R.M.; Methodology: R.M.; Formal Analysis: L.D.M. and R.M.

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