

Social Behavior of Gray Wolves

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Abstract: Gray wolves (*Canis lupus*) show socialization throughout the process of prey, communication and reproduction. Due to the environment of the habitat and characteristic of the prey, acting in group size has an advantage in the subsistence of gray wolves. This survey focuses on cooperation, communication and competition within gray wolves' packs. In this survey, we discuss the aforementioned behaviors found in scent marking, hunting, reproduction, etc. The differences between the independent and the pack wolves are also discussed in this survey.

1. Introduction

1.1 Basic information about gray wolves

The gray wolf, known as *Canis lupus*, is the largest wild member of the Canidae family. It is mainly found in the Northern Hemisphere. They live in habitats like forests, deserts, mountains, tundra, feeding on animals like ungulates and rodents. These places are hard to catch prey alone, so wolves form in groups to increase the success rate of hunting. During the day, they often lie in caves alone or in pairs, but they also come out in sparsely populated areas. When hunting for food at night, they often make a loud howl and chase prey.

1.2 Socialization of wolves

Wolves are sophisticated, clever animals who are compassionate, playful, and most importantly, dedicated to their families. Only a few other species display these characteristics so strongly. Wolves, like elephants, gorillas, and dolphins, raise their young, care for the sick, and live in groups. This kind of behavior is called socialization, which is defined as the process of achieving social and cultural continuity and includes both learning and teaching [1,2].

A wolf pack is a highly complicated social unit. An extended family consists of parents, kids, siblings, aunts, uncles, and outcasts from other packs. There are elderly wolves that need to be cared for, puppies that need to be taught, and young adults that are asserting themselves. All of these are benefit to the packs. They have a highly rigorous hierarchy that all members of the pack must follow. This may appear harsh at first, but it is a mechanism that permits these wolf packs to thrive [1,3].

Even though wolves are unable to write or communicate in the same manner as humans, body language, distinctive odors, and voice are three types of language that may be analyzed inside the social pack. Wolves use their body to communicate a lot. Wolves also have a sense of smell as better as 100 times of humans [4]. They communicate in a number of ways using this sense. Scent-marking is a habit in which wolves mark their territory with urine and scats. When you hear wolves howling in the night, it's not because they're angry with the moon; it's because they're communicating. They may be heard at any time of day, but especially in the evening when the wind has died down and the wolves are most active.

Usually only the dominant pair breeds, however in areas where there is a high ratio of prey per wolf,

such as in Yellowstone National Park, there can be multiple litters per pack. In the western Great Lakes area wolves breed in February through March and after a gestation period of 63 days, four to six pups are born in late-April or early-May. However, the higher the latitude, the later the breeding. For instance, wolves in northern Canada living at a latitude of 71 degrees breed in late March through April [3].

Socialization is considered as a conditioning process that must occur after the formation and in the presence of free expression of the subjective components of fear, as a distinct facet of the broader issue of genetic wildness. Wolves benefit from socialization because it helps them to adapt fast to their surroundings. Wolves are sociable creatures because they can get along with other wolves in a pack. Because of their complicated classes and numerous social activities, socialized wolves hunt cooperatively and have a clear distribution of work among wolves. The ability of wolves to survive in nature is due to socialization. Wolves' ability to compete in nature is due to socialization [5,6].

This paper examines and analyzes the display of social behavior of free-ranging gray wolves in their daily life cycle. In specific, it identifies the social structure of the pack, the communication method, the reproductive behavior and the differences between lone wolves and packed members.

2. Dominance

2.1 Brief introduction of dominance

Social dominance is assumed as an attribute pattern of a relationship that the dominant animal emerge as the consistent winner of the interaction and the subordinate is submissive without aggressive escalation [7]. Wild gray wolf packs are usually family units consisted of a single breeding pair and one or more generations of the offspring [12,13]. The flexible social system of the wolves can also include more complex social members like alien unrelated ones [7]. In the family packs, there is a natural age-based dominance order that the descendants submit to the parents, the puppies submit to the older siblings. In addition, in the wild wolf packs, all the members submit to the breeding pair, and the female tends to submit to the male [7,14]. In the system of the division of labor, with the breeding pair guiding the activities and sharing the leadership, the male is responsible for the foraging and the supply of the food, while the female initiates activities like defense and pup care. What's more, the male helps the female to care and protect the offspring and tends to feed the pups more with the growing age of the pups [10,15]. Furthermore, living in a group of social predators under the dominance can improve the ability to capture prey [16].

2.2 Dominance behavior proof

Dominant behavior can contain a wide range of social interaction, from female wolves' punishment on the pups to full-fledged battles, sometimes leading to the death [17]. Wolves living in social groups mainly consist of relatives with a stable dominance hierarchy. However, the dominant animals win more fights than the subordinates, but they do not fight more often than those [18].

2.2.1 Postures and scent-marking

Dominant wolves adopt the classic candid standing posture with tail at least level up, while subordinate or submissive individuals lower themselves and show their fear. Both the breeding male and female mark things with the scent, and the subordinates will not have that unless they want to fight for the dominance [15].

2.2.2 Food ownership

As the wolves gain food relying on cooperative hunting, food sharing is a significant part for the survival of the group members. What is noteworthy is that there is a food ownership zone around each wolf. Furthermore, regardless of the rank of the wolves, anyone can try to steal food from others, but every wolf defends its own food. In general, dominant wolves are more likely to succeed in food stealing.

In the hunting activity, if the prey is large, pack members of all ranks gather around to feed on themselves at the same time without the rank privilege. Nevertheless, if the prey is smaller, the

dominant animals will feed first and take control of the time of the subordinates feeding. On the other hand, parents will limit the older offspring's food intake and feed the pups instead when there is a shortage of food [12,15].

3. Communication MODE

Wolves are a highly social species and predators in the upper part of the food chain. **Like all the other subspecies of wolves, gray wolves communicate** through body language, scent marking, and vocalization.

3.1 Body language

Gray wolves employ various forms of non-vocal communication to indicate and safeguard their social status in the pack hierarchical system. These are facial expressions, positions of ears and tails, and body movements [19].

Take facial expressions for example. A dominant wolf gives an authoritative stare at a subordinate one, the latter will, in response, adopt a submissive posture. If willingness to submit is not displayed, assertive aggression may arise. Ear and tail positioning is another facial expression, so-termed by scholars. Some typical behaviors implying submission are flat back ears and tail tucked between legs. Aggressive or self-assertive wolves are featured by their slow and deliberate movements.

3.2 Scent marking

The number of wolves in a group is about 5 to 12, up to about 40 in the cold winter, usually led by a dominant pair. Gray wolves use scat and urine to mark territorial boundaries. Several studies on a variety of species, particularly involving males, have suggested that scent marks provide a chemical fence or deterrent that prevents intrusions in a territory by con-specifics [20]. Furthermore, another frequently proposed function is to attract mates [21]. For instance, the female wolves change their urine composition when in estrus to show that she is ready to mate. What is not clearly known is that gray wolves sometimes have scent rolling behaviors. However, scholars have confirmed the fact that wolves coat their fur with an odor if they find something irresistible and unusual.

3.3 Vocalization

In addition to body language and scent marking, vocalization is what gray wolves customarily take to communicate. The sounds they are capable of producing are usually howling, barking, growling, growls, moans, snarls, whimpers, whines and yelps [22].

Each wolf has a distinct howl. It is used to communicate with their pack members the territorial information when they are far from each other. In addition, howling also helps to bring the pack back together when they are dispersed. The field ranges between packs do not overlap, and the respective range will be announced to others with a howl. A lone wolf howls to attract the attention of his pack, while communal howls may send territorial messages from one pack to another. Some howls are confrontational. Much like barking domestic dogs, wolves may simply begin howling because a nearby wolf has already begun [23]. As can be seen, much of the gray wolves' communication is about reinforcing the social hierarchy of the pack, which evidently supports that wolves are social animals.

4. Reproduction

4.1 Breeding priorities

Wolves also follow their social orders during breeding seasons. Mech's study [15] explains that the leading male and female (in other words, the parents of the pack) receives the right to mate and breed wolf puppies, so there would be only one litter of pups per year. The rest of the pack would aid their parents to raise their pups. However, it's not rare that there is more than one litter in the pack. Cluff et. al reported a case in northern Canada, where they spotted three female wolves caring pups in two different sites of the pack territory [24]. Other than that, researchers also reported cases of three litters at one den site in both Yellowstone and Denali National Park. The major theory is that the breeding

females are related as mothers and daughters. The daughters' mate might be adopted males from other packs [10].

There are two main reasons that the leader couple actively resists breeding activities of their companions. First, Mech [25] and Haswell [26] observed that wolf packs are usually composed of the alpha male, the alpha female, their offspring, and in some cases a post-reproductive elder in the family. Their kinship binds the entire pack together. This indicates that breeding within the pack other than the dominant male and female would be considered as inbreeding. Although inbreeding might not cause harm between the parents, it would have a high possibility of boring unhealthy litter. Second, given the long time for the pups to grow and the large amount of food required, the whole pack needs to forage and take care of the pups to ensure living. The harsh environment and the scarce prey already keep the chance of survival low. If the pack needs to increase that burden, it would cost much more for them to raise all litter.

4.2 Special behavior

Starting at the late winter, the breeding male and female would build up or strengthen their relationships by special courtship behavior. In this case the couple would display movements including sniffing, snuggling, head rubbing and other playing moves with considerable amount of body contact. In some cases, as shown in the videos by Wolf Conservation Center [27], wolves cuddle together tightly to show their affection towards each other, which generates a positive bond. They keep close for two months before the estrous period. After the tight bond is formed, the male wolf would constantly sniff the vulva part of the female to check if the body of female wolf releases the sex hormone and becomes ready for copulation [26]. At the start of copulation, the male's penile gland and the female's vulva form a copulatory tie, so they are unable to move. This makes them extremely vulnerable, especially the whole process last for at least 5 minutes because they need to avoid harassment from other males in the pack or threats from other species of animals. Hence, after a short amount of time, the male would dismount the female while they are still physically bonded together.

In order to protect the pups, breeding female wolves would display denning behavior to keep their pups in a safe place. Usually, it is located at the center of the territory, where the pups are undisturbed by other packs or outside threats [28]. In some cases, the pack would choose a surface den covered by intense vegetation. If the mud is suitable for holes, they might dig one or find an empty burrow made by other carnivores. To ensure more safety, the packs transfer their pups to a different den site. Alfredéén [29] observed that one breeding female moved her pups away from the original den sites on the second day which were possibly discovered by illegal hunters. Other than that, the pack would also move away from the natal den site when the pups reach an age averaged 44 days.

During breeding seasons, the breeding male and female wolves become more dominant. When the female bore her litters in April or May, the signs of the breeding pairs initiating the pack's movement increase [8]. She shows the most care to the cubs although other members of the pack also show some care to the cubs. While the pack as a whole would show more care to the cubs, the parents demonstrate the most aggressive behavior when they sense potential threat to pups. Murie [30] recorded an incident when a Grizzly Bear approached a wolf pack with pups. He noted that the breeding pair demonstrates the most aggressiveness and persistence.

5. Contrast of the Independent and The Pack Wolves

5.1 The formation of lone wolves

When a wolf leaves its original place, or once it was born, it becomes a lone wolf [31]. This kind of phenomenon is called dispersal. It often happens between the ages of 1 and 2 years old [32], coinciding with sexual maturity. Lone wolves are uncommon rather than the rule, as wolves naturally form packs and enjoy social interaction. According to research, dispersed wolves account for less than 15% of the world's wolf population. However, because prey is usually smaller in Europe, lone wolves are more common [31].

5.2 The types of lone wolves

There are three types of wolves [31,33]. The first is solitary existence. Solitary wolves are usually low-level wolves who have broken away from their wolf pack. The wolf is banished for lack of aptitude or failure to challenge the wolf king, and the wolf king's offspring may break away from the pack to find a mate when they reach adulthood. The second option is to live in pairs [34]. When a male wolf falls in love with a female wolf, he separates from the pack and starts a wolf pack. The third form is that lone wolves join the pack life, which consists of 5 to 11 wolves, with one dominant male serving as king, the others being females and offspring.

5.3 Comparison of prey efficiency

Previous research has discovered that lone or partnered wolves have a higher hunting success rate than bigger groups, despite conventional perception that larger packs make hunting easier [35]. Wolves prey on smaller animals and have a greater hunting success rate when they act alone or in pairs. Huge wolves, on the other hand, prefer to prey on large prey like musk ox and moose, which has a lower success rate, in order to shorten hunting times and satisfy their survival demands. Table 1 shows the conclusion of difference between the independent and the pack wolves.

Table 1 Difference between the independent and the pack wolves

Living style	Independent	Pack
Quantity	Small	Large
Prey efficiency	Higher	Lower
Fertility	Higher	Lower
Hazard response	Lower	Higher

5.4 Comparison of hazard response (efficiency)

A wolf pack is a cohesive family unit made up of the current year's adult parents and their kids, as well as maybe prior years' offspring, and sometimes two years or more [31]. Wolves are a well-organized and disciplined pack that has its own set of rules and designated personnel for hazard response [36]. Lone wolves will enhance their hazard response capacity by joining a new wolf pack or starting a new family. Otherwise, lone wolves have a terrible time surviving in the wild, and their hazard response efficiency is significantly lower than that of wolves.

5.5 Comparison of fertility

The genetic diversity of wolves is increased because lone wolves choose to leave the group to live in the outer world and breed without selecting close relatives. Only the pack's dominant Wolf (the alpha) is allowed to mate with the opposing sex [36]. Other lower-ranking wolves either leave the pack to mate or mate with permission from the leader.

6. Conclusion

Overall, the social behavior of different wolves shapes their lifestyle and daily movement. They create their social connection based on their family, which prevents power challenges as least as possible since the parents can have the maximum control over their offspring. The lead-up position of the parents is displayed as the initiation of hunting and patrol and the direct intervention of food distribution. Among the pack, members use specific body movements and voices to exchange information. In addition, the howling and the voices they make allow the pack to distinguish between members and invaders. When wolves reach the reproductive season, they also follow their role in the pack where the parents get to mate and raise their kids. Meanwhile, the rest of the pack takes up the responsibility to take care of and protect the newborn cubs. The tight connection between each member in the pack allows the whole pack to survive more successfully, which also limits the success rate of hunting and survival when they are alone. Thus, the basic life of wolves is tightly based on their connection with the pack.

Authors' contributions

These authors contributed equally.

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