# FEEDING AND TERRITORIAL BEHAVIOR OF RED DEER (*CERVUS ELAPHUS*) IN SUBMONTANE HABITATS

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***Abstract***

*The aim of this study was to investigate the feeding and territorial behavior of red deer (Cervus elaphus) in submontane habitats, integrating field observations with data from the specialized literature. The method involved reviewing relevant studies and analyzing information provided by hunting fund managers regarding seasonal movements, social structure, feeding patterns, and responses to anthropogenic disturbances. Results showed that feeding behavior is highly seasonal, with a preference for grasses and young shoots in summer and reliance on supplemental feeding during winter. Territoriality is most pronounced in males during the rutting period (September–October), with social structures varying seasonally: females form herds with calves, while males are solitary or move in small groups outside the rut. Abiotic factors such as snow cover, temperature, and wind, as well as biotic factors like food availability, strongly influence movement patterns and habitat use. Management practices, including controlled artificial feeding, habitat protection, and modern monitoring techniques (GPS tracking, camera traps, motion sensors), were found to mitigate anthropogenic pressures and preserve natural behavior. These findings highlight the importance of integrating ethological observations with habitat and management data to support sustainable conservation of red deer populations in submontane environments.*

***Key words:*** *red deer, territoriality, seasonal movements, submontane habitats*

## INTRODUCTION

The red deer (*Cervus elaphus*) is one of the most important game species in the submontane regions of Romania, with a wide distribution across the Eastern and Southern Carpathians and the Subcarpathian area. Owing to its ecological plasticity and adaptability to habitat variations, this species serves as a valuable indicator of ecological balance and of the effectiveness of applied management measures [1].

While other game species may exhibit greater adaptability to the expanding influence of human activities within their habitats, the red deer is particularly sensitive to anthropogenic pressures such as grazing, logging, tourism, hunting, and poaching. These factors can lead to population declines or even the local disappearance of the species in severely affected areas. The behavior and persistence of red deer populations are therefore closely correlated with the intensity of human disturbance and habitat quality [2].

The protection and conservation of red deer, as well as its sustainable hunting, require highly trained field personnel equipped with both solid theoretical knowledge and appropriate practical tools. Since male deer can only be harvested at a relatively advanced age in order to obtain high-quality trophies at their peak development, it is essential to ensure tranquility in the field and the availability of refuge areas that allow individuals to reach their full potential. Consequently, maintaining a balance between population size and the carrying capacity of the ecosystem is important to prevent damage to forest vegetation within the hunting grounds [3].

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Regardless of the challenges associated with its management, the red deer is the largest mammal among game species, and its presence on any hunting ground significantly enhances both the economic and faunal value of the area.

From a behavioral perspective, the rutting period is particularly remarkable. During this season, many mature males can be observed as they emerge from remote areas and abandon their typically reclusive behavior. For these reasons, deer hunting during the rutting season is considered by specialists to represent the highlight of the hunting year [4].

The distinctive characteristics of the red deer have led hunting ground managers, specialized personnel, and professional hunters to prioritize the protection of this game species. A decline in deer populations requires highly costly and long-term measures to restore the lost numbers [1].

The aim of this paper is to highlight the specific features of the feeding and territorial behavior of red deer (*Cervus elaphus*) in submontane areas, in relation to environmental factors and anthropogenic pressure. The main objectives are to analyze seasonal variations in feeding behavior, patterns of territorial use, and the influence of human activities on the species' daily routine. The study is based on the hypothesis that the intensity of anthropogenic pressure and the quality of the habitat drive significant behavioral adaptations, which in turn affect the distribution and stability of populations.

## MATERIAL AND METHOD

The paper is based on bibliographic analysis and applied observations carried out in various hunting grounds within submontane areas. The theoretical information was obtained through the consultation of scientific papers published in specialized journals, game management reports, and studies on the ethology of red deer (*Cervus elaphus*) at both European and national levels.

For the applied part, data provided by local hunting fund managers were analyzed regarding: (1) feeding and movement behaviors observed during different seasons; (2) areas frequently used for feeding, shelter, and reproduction; (3) the influence of anthropogenic activities (forestry, tourism, grazing, hunting) on the daily routines of the species.

These observations were supplemented with synthetic data from fauna monitoring reports and, where possible, with thematic maps and graphs illustrating seasonal variations in red deer behavior.

The comparative analysis aimed to correlate feeding and territorial behavior with environmental factors and anthropogenic pressures specific to submontane hunting grounds.

## RESULTS AND DISCUSSIONS

The presence of game within a hunting ground, as well as its movements and behaviors, is influenced by numerous biotic, abiotic, and anthropogenic factors. The main factors affecting the ethological behaviors of red deer in submontane areas are: (1) climatic conditions, which determine seasonal altitudinal migrations; (2) habitat fragmentation, which limits natural movement routes; (3) the intensity of human activities, such as forestry and tourism; (4) management measures, including density regulation and supplementary feeding.

Table 1 presents a comparative analysis of the ethological behaviors of red deer and other species of hunting interest. Under submontane conditions, red deer exhibit feeding behavior characterized by pronounced seasonality, influenced by vegetation structure, resource availability, and the degree of anthropogenic impact. During summer, their diet is dominated by grasses, leaves, and young shoots, with a preference for open areas, clearings, and

forest edges. In winter, as resources become scarce, the animals migrate to lower altitudes and rely on supplementary feeding organized by hunting ground managers, consisting mainly of hay, corn, and root crops.

Studies by Gebert & Verheyden-Tixier [5] show that artificial feeding partially alters natural foraging behavior, reducing mobility and daily grazing time. In some hunting grounds (as reported in other studies), animals were observed to frequent feeding areas more intensively from December to March, while daytime activity decreases and is replaced by nocturnal movements to food sources.

Male red deer exhibit pronounced territorial behavior, particularly during the rutting period (September–October). Territories are marked acoustically (through roaring) and olfactorily (via scent marking). The social structure is seasonal: outside the rut, males live solitarily or in small groups, while females form herds with calves. In submontane forests with high population densities, increased aggressive interactions among males and expansion of rutting territories have been observed, indicating heightened competition for reproductive resources. Recent studies [6] confirm that these ethological behaviors can serve as indicators of the social and reproductive equilibrium in managed populations.

Based on data from the specialized literature and observations reported by hunting fund managers [7], the balance between population density and habitat trophic capacity is essential for maintaining natural behaviors. Gregarious species (deer, wild boar) respond more strongly to changes in density and anthropogenic pressures, whereas solitary species (roe deer, bears) exhibit more pronounced individual adaptations.

Regarding the influence of abiotic factors, deer behavior is strongly affected by the presence and duration of snow cover, particularly given that herbaceous vegetation constitutes a large portion of their diet-50–60% in winter and up to 80% in summer. Heavy snow limits access to food, forcing deer to migrate to sunny slopes where snow melts more quickly; on sunny winter days, herds may remain in these areas for several days. However, some authors [1,8] note that, even in the absence of abundant food, if disturbances are minimal, deer can remain active throughout the day and may not leave the area.

Table 2 highlights seasonal behavioral dynamics: in autumn, rutting activities intensify in both red deer and roe deer, whereas in winter, social and foraging behaviors associated with artificial feeding (wild boar, deer) predominate. Movement activity, on the other hand, reaches its maximum in summer, coinciding with the dispersion of trophic resources. Fig. 1 illustrates the predominance of movement activities during summer, the intensification of rutting in autumn, and the increase in social interactions during the cold season, which correlate with periods of artificial feeding and herd concentrations. In terms of environmental conditions, wind also has a significant influence on red deer behavior. Although the hair of deer provides good thermal insulation by trapping air within its structure, this protection is insufficient during blizzard conditions. In this context, observations by Jackson & Fahrig [9] indicate that under strong winds, deer retreat to more sheltered areas, particularly among young trees, which offer both protection and a lower risk of breakage during storms. While forest stands offer clear advantages for shelter during harsh weather, Smart et al. [10] and Kilpatrick et al. [11] noted that strong winds may also create indirect benefits for red deer. The breaking or falling of spruce trees can provide access to fresh pine needles and crown lichens, which serve as valuable food sources during the winter.

Table 1 Primary ethological behavioral patterns of game species in submontane areas

| Species | Specific ethological behavior | Eating behaviors | Territorial and social behaviors | Main factors | Seasonal influences | Implications for sustainable management | Local hunting ground observations |
|---|---|---|---|---|---|---|---|
| **Red deer (*Cervus elaphus*)** | Formation of mixed herds outside the mating season; pronounced territorial behavior during the rut. | Seasonal diet (grasses in summer; shoots and branches in winter); higher intake during supplementary feeding. | Males become territorial during the rut (Sept–Oct); display bucking and ritual fights; flexible social structure (groups of females with calves). | Climate, population density, food availability, tourist pressure. | Increased activity at forest edges in autumn; intensified nocturnal movements during hunting season. | Control of supplementary feeding; maintenance of migration corridors; reduction of disturbances during the rutting period. | Frequent movements to clearings and agricultural fields in September–October; avoidance of heavy tourist traffic areas. |
| **Roebuck (*Capreolus capreolus*)** | Solitary behavior; pronounced territoriality during the breeding season. | Selective feeding (young plants, buds, tender leaves); sensitive to vegetation changes. | Pronounced male territoriality during the breeding season (July–August); females more sedentary. | Habitat fragmentation, agricultural activities, interspecific competition; avoidance of disturbances during calving season; maintenance of natural vegetation strips. | Diurnal activity in spring; predominantly nocturnal in summer. | Protection of transition areas between forest and agricultural land; regulation of population densities. | Regular movements between forest edges and cultivated lands; increased frequency of solitary individuals in June–July. |
| **Wild boar (*Sus scrofa*)** | High gregariousness; predominantly nocturnal activity; trophic adaptability. | Opportunistic omnivore; strong attraction to artificial feeds; potential to damage crops. | Matriarchal social structure; males solitary outside the breeding season. | Abundance of trophic resources; anthropogenic interventions; climatic conditions. | Reduced mobility in winter (around feeders); increased mobility in summer. | Limiting feeding to prevent overpopulation; measures to avoid conflicts with humans. | Flocks concentrate around artificial food sources in winter; significant crop damage in summer. |
| **Hare (*Lepus europaeus*)** | Solitary behavior; nocturnal activity. | Consumes herbs, leaves, and roots; nocturnal feeding behavior. | Reduced territoriality; predator avoidance; high mobility. | Hunting pressure; changes in agricultural habitats. | More active in spring and autumn. | Provision of refuge areas; reduced hunting during critical periods. | Frequent observations in transition zones between pastures and agricultural lands, especially in April–May. |
| **Brown bear (*Ursus arctos*)** | Solitary behavior; extensive territory; increased activity at dusk. | Omnivorous diet; reliance on seasonal resources (fruit, carcasses, waste). | Solitary with vast territories; opportunistic behavior; increased activity near anthropogenic sources. | Waste management; availability of natural food. | Increased trophic activity in spring and autumn. | Prevention of artificial feeding; public education on preventive behaviors. | Frequent movements along forest corridors near berry areas; sporadic interactions with isolated households. |

Table 2 Variation in the frequency of behaviors observed in submontane game species

| Season | Feeding | Movement | Reproduction | Social activity |
|---|---|---|---|---|
| Spring | 25% | 30% | 10% | 15% |
| Summer | 20% | 35% | 20% | 25% |
| Autumn | 30% | 25% | 40% | 20% |
| Winter | 25% | 10% | 5% | 40% |

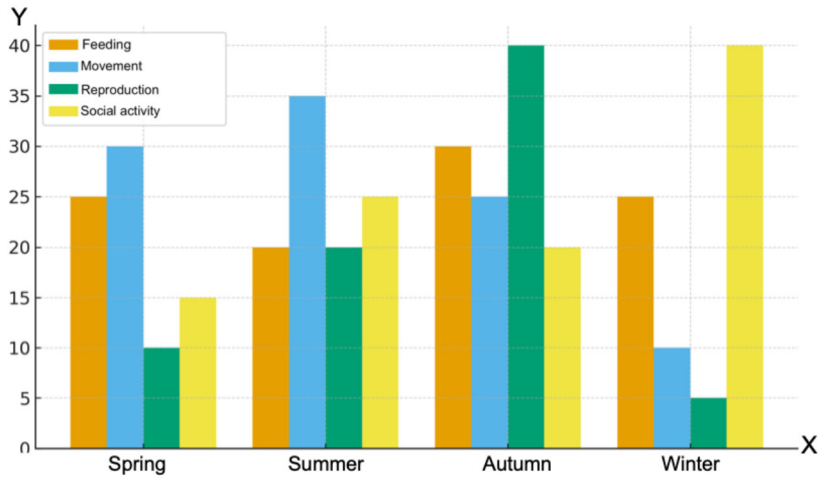


Fig. 1 Seasonal variation in the frequency of ethological behaviors observed in submontane game species (X – Season; Y – frequency of observed behaviors %)

Regarding temperature, during very hot summer days, deer herds tend to move toward shaded areas, particularly along valleys or on north- and west-facing slopes. In winter, when snow cover persists for extended periods, herds tend to migrate toward lower valleys [11]

Regarding biotic factors, the survival and development of red deer depend fundamentally on the availability of preferred plant species. In general, an adult deer consumes approximately 20 kg of food per day during the vegetation period, while in the cold season, intake decreases to 6–10 kg per day. When food is abundant within the habitat, deer movement is typically reduced. During winter, red deer exhibit a lower metabolic rate and limited mobility, remaining mainly in areas with raspberries and soft deciduous trees, in old bilberry forests, or in zones with felled trees that provide access to food from crowns. In summer, red deer herds concentrate primarily in pastures with succulent grasses, which represent an important nutritional resource [12].

By its ecological nature, the red deer requires extensive areas to meet its needs for food, shelter, mating, and rearing of young. Both individuals and herds move over variable distances depending on the characteristics of the area they inhabit and are generally difficult to monitor [4].

To assess individual movement, telemetry methods are commonly used in the scientific literature. Research conducted in Austria indicates that young deer exhibit the highest mobility, characterized by pronounced territorial behavior and a well-defined home range, covering distances of up to 450 km per year and movement between 10 and 25 km [13,14].

Currently, habitat fragmentation caused by the development of human settlements, the expansion of traffic infrastructure, the increase of cultivated land, and other similar factors has led to significant migration among red deer and other game species. Among these, deer are the most vulnerable to human-induced disturbances, and prolonged lack of tranquility within the hunting grounds can result in the complete displacement of herds to quieter areas [15,16]. According to VerCauteren et al. [16], numerous human activities can negatively affect the development of deer populations.

In the first half of September, herds of domestic animals typically descend from mountain valleys toward the settlements, creating feeding opportunities for red deer, which in turn move to higher altitudes, followed by the stags. While females tend to be more territorial and move less in search of food, males can travel considerable distances-up to 50 km-in search of females. During the rutting period, stags actively seek out females and may move continuously, even during the day. Once harems are established, dominant and secondary males restrict their movements to the ranges used by females for feeding. Within a herd, several younger males may occasionally be present but generally maintain a distance from the dominant male. As for conflicts, direct confrontations between males are relatively rare, as they tend to avoid fights that could cause serious injuries or even death to the weaker individual.

Very old stags are difficult to observe because they avoid open areas and remain extremely cautious, even during the rut, when they are typically focused on a single doe in estrus. On average, the rut begins sporadically around September 15, intensifies after September 20, reaches peak activity between September 27 and October 3, and then gradually declines until about October 10. In areas inaccessible to humans, rutting activity can also occur during the daytime, a phenomenon generally observed in steep, undisturbed habitats-an aspect that reflects the natural, undisturbed behavior of red deer. In fragmented or heavily exploited areas, stags are much more disturbed, showing predominantly nocturnal activity, which makes observation and the planning of controlled hunting activities more difficult.

## CONCLUSIONS

The ethological behaviors of red deer (*Cervus elaphus*) serve as important indicators of ecological balance and the effectiveness of hunting management. Observations of feeding patterns, territoriality, and seasonal activity enable indirect assessment of anthropogenic pressures and the efficiency of management practices in submontane hunting grounds.

Artificial feeding should be implemented in a controlled manner, respecting critical periods of the year to prevent dependence on human-provided food and alteration of natural feeding routines. Improper management of these practices can result in local crowding, stress, and disruption of natural behaviors.

The integration of modern monitoring techniques-such as video cameras, motion sensors, and GPS tracking-offers new insights into wildlife behavior and allows management measures to be adjusted based on objective data. Correlating ethological observations with environmental factors and anthropogenic pressures supports the development of sustainable management strategies, ensuring the long-term conservation of red deer populations in submontane areas.

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