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Habitat selection of alpine chamois under different climatic conditions in the Alpine and Carpathian mountain chains

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Abstract

In its native environment alpine chamois occupies habitats from montane to alpine altitudinal zones of the Alps. The introduction into the forested foothill and montane altitudinal zones of the Carpathians exposes the species to diverse weather and climate conditions. We discuss differences in habitat selection under boreal-alpine climate conditions and humid continental climate conditions based on long term monitoring data (Berchtesgaden National Park) and field studies (Great Fatra National Park).

Keywords

chamois, habitat selection, climate, weather, Alps, Carpathians, Berchtesgaden, Great Fatra, national park

Introduction

Weather and regional climate have been long recognized as the main factors influencing the biotic systems (FIRSINA & FIRSINA 2008). In the case of ungulates inhabiting a certain climatic region the influence of climatic conditions is one of the major limiting factors for the species distribution. In general alpine chamois is considered to occupie habitats from montane to alpine altitudinal zone of the Alps with seasonal changes in habitat selection, which are repeated periodical every winter and summer (KNAUS & SCHRÖDER 1975). The common pattern for the chamois population in the Alps is characterized by a seasonal vertical migration between the higher subalpine and alpine zones in summer and the lower montane forest zones in winter (ELSNER-SCHACK 1985). In 1955 a population of alpine chamois was introduced to the Carpathian National Park Great Fatra (SOKOL 1965). In the area neither a subalpine or an alpine zone exist. In this montane forested environment, vertical migration is virtually excluded and chamois population is exposed to other climatic conditions, as in the natural area of species distribution (ORAVEC 2010). We discuss the habitat selection of alpine chamois under different climatic conditions of the Alps and Carpathians based on long term monitoring data (Berchtesgaden National Park) and field studies (Great Fatra National Park).

Methods

The research area in the National Park Berchtesgaden, which represents the native environment of alpine chamois, is situated in south-east Germany (Bavaria) in the Northern Limestone Alps. The National Park is located in the climatic transition zone between temperate oceanic climate and cool continental climate (KONNERT 2004). The altitude difference of 2110 meters creates typical mountain local-climate that affects the variation of main meteorological factors (KRALLER 2008). That creates extremely diverse conditions with habitats range from hard oligo-mesotrophic waters with benthic vegetation of *Chara spp.* to permanent glaciers (LANG & WALENTOWSKI 2008). Large predators are not present and chamois hunting is only allowed in the buffer zone of the National Park. The Data were collected by observers in Jenner and Watzmann area since 1997 until the year 2012 (LOTZ 2000). Recorded was location, total count of individuals, sexual and age structure. The environmental variables where extracted with GIS. No further statistical analysis was undertaken and the data are not published yet.

The area of the field studies in the Carpathian Mountains is located in the middle Slovakia in the south-west part of the National Park Great Fatra. The introduced individuals are influenced with warm continental and temperate continental climate (VESTENICKÝ et al. 1986). The research area is a mountainside between foothill and montane altitudinal zone predominated by Medio-European limestone beech forests, secondary originated non forest areas and limestone rock habitat with Western Carpathian calcicolous *Pinus sylvestris* forests, with the highest elevation 1069 m a.s.l. All large predators are present in the area and chamois hunting is allowed. The data on the chamois population were recorded since 2008 until 2010 with continual focal animal sampling method (MARTIN & BATESON 2007). The total number of individuals, habitat unit and their activity was collected. The significance of differences in habitat selection was tested by a single-factor variance analysis ANOVA. Nonparametric Kruskal-Wallis single-factor analysis, its associated Kruskal-Wallis multiple comparison test and Tukey-Kramer multiple comparison test were used to test the differences. All tests were made at a significance level of 0.05.
The habitat types were very specifically structured for each project target in both areas (e. g. Rock edges, Bottom of cliffs). In order to match the habitat types, they were all grouped into three general categories: Forest area, Non forest area, Rock and scree area.

Time periods of the year are bimonthly grouped (e. g. January - February). In National Park Berchtesgaden the data has been collected yearly from May to October and the data from November to April are not available.

Results

Tab. 1 summarizes the preferred habitat selection of the chamois under different conditions of Alps and Carpathians. The important environmental variables for the species and both study areas are listed.

Prefered Environmental Variables	National Park Berchtesgaden	National Park Great Fatra
Avg. Altitude (Meters)	1697,5	887
Exposition	West	South
Avg. Slope (Degrees)	36,2	36,5
Habitat type	Rock and Scree	Forest area

Table 1: Preferred habitat selection of chamois in National Park Berchtesgaden and Great Fatra (own representation)

The average elevation selected by chamois in Berchtesgaden Alps is greater than the average selected elevation in Great Fatra Mountains. The chamois in both areas select slopes with equal inclination. The predominant exposition selected in National Park Berchtesgaden is west and south-west. In the Great Fatra National park individuals select mostly the south sides. Rock and scree habitats were selected by chamois in the alpine environment and forest areas (Medio-European limestone beech forests) dominated in the selection of the Carpathian chamois (HURTA 2009).

Fig. 1 shows the habitat selection of chamois in Berchtesgaden (B) and Great Fatra (GF) National Park. In bimonthly time periods of May – June (M - J), July – August (J - A) and September – October (S - O) the chamois in the Carpathians mainly selected the forest areas. The selection by the chamois in the Alps remained constant over this three bimonthly time periods. Statistical significant was the selection of the forest areas in the Carpathians by chamois in the time period May – June (Kruskal-Wallis nonparametric test, $H_{0.05,\ 5,\ 375} = 15.74$; $p = 0.007642$). The individuals selected the forest areas more often as in the rest of the year. The total number of individuals was also higher in this period of the year as in the winter periods ($\beta = 0.346$, Wald $\chi^2 = 11.46$, $p = 0.0007$) (ORAVEC 2010). The average selection of forested areas by chamois in Great Fatra is twice as much as the selection of forested areas in Berchtesgaden.

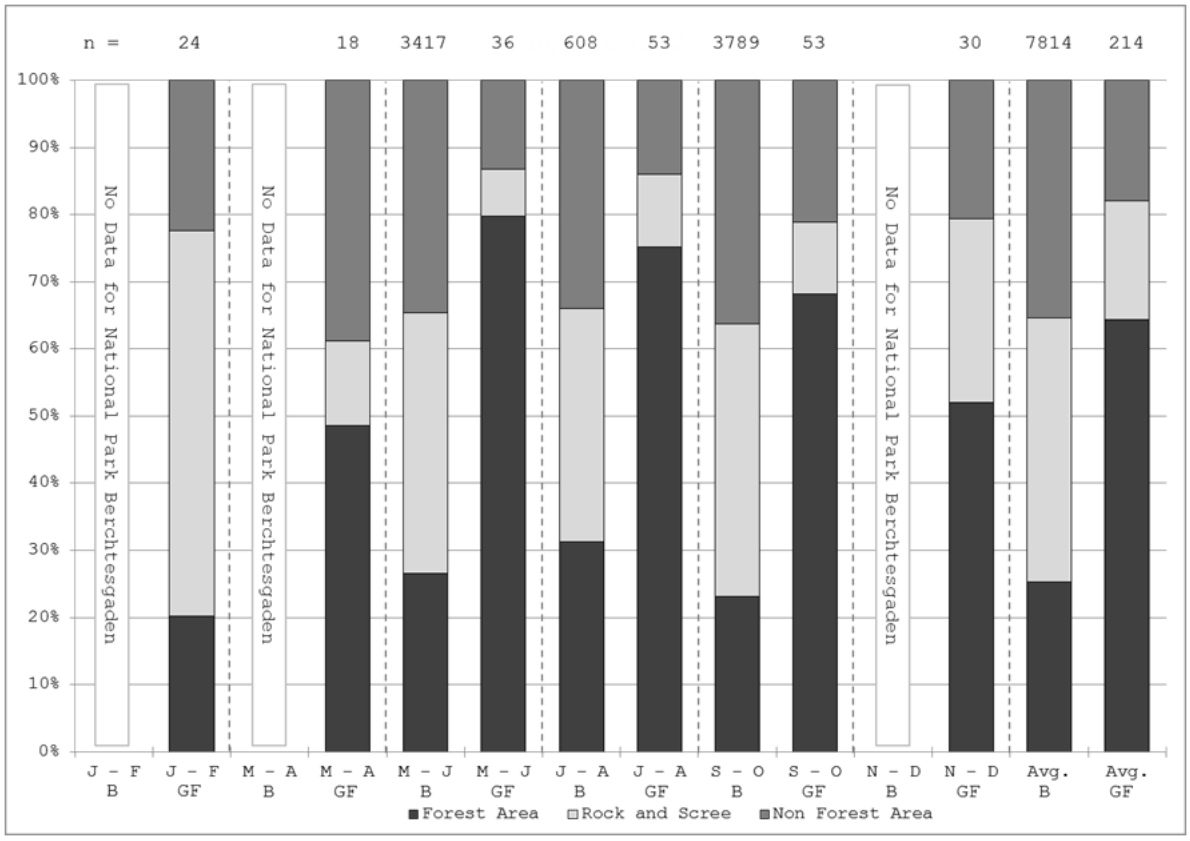

Figure 1: Habitat selection of chamois in National Park Berchtesgaden (B) and Great Fatra (GF) grouped by bimonthly periods (ovn representation)

Discussion

The chamois population in the Alps is characterized by a seasonal vertical migration (ELSNER-SCHACK 1985). In summer chamois selected higher altitudes. The reason is the availability of qualitative food supplies, lower ambient temperature and better visibility of the environment (JAMROZY et al. 2007). Chamois in Carpathians select in summer months predominantly the forest areas (ORAVEC 2010). Such similar patterns have been observed in the forest living populations in Switzerland (BAUMANN & STRUCH 2001), Czech Republic (JIRÁT 2000), Spain (GARCIA-GONZALEZ & CURTAS 1996) and New Zealand (YOCKNEY & HICKLING 2000). The migration in higher altitudes in summer like in the alpine native environment is not possible and the individuals are forced to adapt to the new conditions. The significantly higher selection of forested areas by the individuals in the bimonthly periods of May – June, July – August and September – October is probably caused by a behavioral thermoregulation. The animals select the coldest habitat and lower their activity level in the summer months. This is a strategy of the individuals to avoid the heat stress and to keep the energy expenditures for body cooling at its lowest. This strategy may be the clue to overcome the conditions in warm climatic regions where the possibility to vertically migrate in higher altitudes is not given. The strategy was observed in other ungulates such as *Alces alces* (LOWE et al. 2010), *Tragelaphus strepsiceros* (OVEN-SMITH 1998) and *Capra hircus* (SHI et al. 2006). The populations that live under these different conditions such as the population in Great Fatra or individuals in the Nature Park Upper Donautal show that the species has a broader ecological valance than has been claimed. The resulting factor of the chamois distribution in an area is not the altitude but the steepness of the terrain, which is the common factor for both areas in our comparison Table in the chapter Results. The adaptability and broad ecological optimum shows the introduction of chamois to the Mount Cook Mountains, New Zealand, in 1907 (YOCKEY & HICKLING 2000).With an absence of natural predators and hunting pressure individuals spread to lower steep forested areas near the sea level. In the Great Fatra, individuals of alpine chamois were introduced to foothill and montane zone in 1955. Their genetic information can be now found in the population of tatra chamois (*Rupicapra r. tatrica*) that inhabits the subalpine zone of the Low Tatra Mountains (ZEMANOVÁ et al. 2015). This is the present evidence that the species can occur also in low range mountains or even in steep lowland landscapes. The historical evidence shows that chamois not only occurred in the highest mountains. Fossil findings of chamois skeletons from caves and excavations all over Europe show that the glacial Pleistocene distribution of the species was much larger than today (JAMROZY et al. 2007). The Alps where covered with glaciers and the ice age chamois was forced to use steep slopes in the low altitude mountains. There are some similarities with the introduced population in the National Park Great Fatra, but not the warm climate. How affects warm climate the survival or reproduction rates, behavior and seasonal patterns of chamois in Great Fatra? Is the species adaptability and ecological optimum greater than we supposed? That could be new research questions for species that live in such different environmental conditions.

Conclusion

Chamois are considered to be an alpine species, which is contradictory to the occurrence of an introduced population in Great Fatra National Park.

Individuals in both areas select the common steepness of the slopes. Differences become apparent in habitat selection, where chamois in the Carpathians select more often forested areas as chamois in the Alps. The switch in Habitat selection towards the forested areas may due to warmer climatic conditions and impossibility of vertical migration. Research on chamois populations in predominantly forested environments can bring new insights into adaptability and ecology of this species.

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