Turkish Journal of Forest Science
Available online at dergipark.gov.tr/turkjforsci

EFFECTS OF THINNING AND GRAZING ON THE FUNCTIONAL CHARACTERISTICS OF THE GROUND VEGETATION IN FIR-CEDAR-FORESTS IN THE CENTRAL TAURUS MOUNTAINS, TURKIYE

Yıldız GÜNEŞ

Department of Physical Geography, Plant Ecology and Sociology, Kahramanmaras Sutcu Imam University, Kahramanmaras

Corresponding author: yildizgunes@ksu.edu.tr

Yıldız GÜNEŞ: https://orcid.org/0000-0003-2614-9615

Please cite this article as: Gunes, Y. (2023) Effects of thinning and grazing on the functional characteristics of the ground vegetation in fir-cedar-forests in the central taurus mountains, Turkiye, *Turkish Journal of Forest Science*, 7(2), 155-177

ESER BILGISI / ARTICLE INFO
Araştırma Makalesi / Research Article
Geliş 5 Haziran 2023 / Received 5 June 2023
Düzeltmelerin gelişi 2 Ağustos 2023 / Received in revised form 2 August 2023
Kabul 16 Ağustos 2023 / Accepted 16 August 2023
Yayımlanma 30 Ekim 2023 / Published online 30 October 2023

ABSTRACT: The forests of *Cedrus libani* and *Abies cilicica* in the middle Taurus Mountains in southern Turkiye are heavily degraded by traditional land use. Population, working in the agricultural sector migrates in summer with their cattle, sheep and goats from lowlands to highlands because the pastures there are prolific due to higher precipitation. The forests have been opened up by grazing and timber cutting. Both effects on the ground vegetation of forests with cedar and fir are examined in the study. Intensive grazing changed the plant species composition as the animals prefer tasty as food. This has led to dominance of inedible plant species, like thorny, prickly, poisonous species and those armoured species with rosettes. Although the sensitive species were reduced by intensive grazing, plant diversity increased. While the rate of hemicryptophytes, camaphytes and geophytes is generally high in the study area, the rate of therophytes is quite low. Generally, the perennial plants were favoured by grazing. On the other hand, the annual species preferred by the cattle fell back. The effect of timber use by illegal logging shows that light demanding plant species have colonised the lighter parts of the formerly closed and semi-closed forests.

Keywords: Thinning, fir-cedar-forests, grazing, Changes in species composition, species characteristics.

TÜRKİYE'NİN ORTA TOROS DAĞLARI'NDA KÖKNAR-SEDİR ORMANLARINDAKİ ARALAMA KESİMLERİ VE OTLATMANIN YER BİTKİ ÖRTÜSÜNÜN FONKSİYONEL ÖZELLİKLERİNE ETKİLERİ

ÖZET: Türkiye'nin güneyindeki orta Toros Dağları'ndaki *Cedrus libani* ve *Abies cilicica* ormanları, geleneksel arazi kullanımı nedeniyle büyük ölçüde bozulmaktadır. Bölgede geleneksel yaşam tarzına sahip insanlar, yaz aylarında büyükbaş, koyun ve keçileriyle ovalardan yaylalara göç eder, çünkü oradaki meralar yağışların yüksek olması nedeniyle verimlidir. Orman içi otlatma ve illegal ağaç kesiminden dolayı orman içi aydınlatılmıştır. Çalışmada sedir ve köknar ormanlarında, orman içi otlatma ve ağaç kesiminin toprak bitki örtüsü üzerindeki etkileri incelenmiştir. Hayvanlar yiyecek olarak lezzetli türleri tercih ettikleri için yoğun otlatma yapılan yerlerde bitki türlerinin kompozisyonu değişmiştir. Bu durum hayvanların tüketmediği dikenli, aromalı ve toksit madde içeren türlerin bölgede dominant duruma geçmesine yol açmıştır. Yoğun otlatma yapılan sahalarda bazı hassas türler azalma gösterirken, genel olarak bitki tür çeşitliliğinde artış gözlenmiştir. Çalışma alanında hemikriptofit, kamafit ve geofitlerin genel olarak oranı yüksekken, buna karşın therofitlerin oranı oldukça düşüktür. Genellikle otlatma sahasında çok yıllık bitkilerde artış mevcutken, hayvanlar tarafından tercih edilen tek yıllık türlerin oranında azalma gözlenmiştir. İllegal ağaç kesimine bağlı olarak oluşan orman içi aydınlatması sonucunda ise yarı ışık ve ışık istegi yüksek olan türlerin orman içindeki oranında artış tespit edilmiştir.

Anahtar kelimeler: Aralama, köknar-sedir-ormanları, otlatma, tür kompozisyonundaki değişiklikler, tür özellikleri

INTRODUCTION

Due to its geographical location and heterogeneous topographical climatic conditions, Turkiye is one of the richest plant species in Europe and the Middle East (Mayer and Aksoy, 1986). Its flora comprises about 12,000 species of wild-growing vascular plants (Davis, 1965-1988). Around 3,300 species (31%) are endemic of which 1,700 are classified as rare and 200 as endangered (ÇB, 2004). In addition, Turkiye is an important gene centre for many crops (Davis, 1965-1985).

For the millennia, the Mediterranean ecosystems have been intensively used and thereby degraded. This has led to severe fragmentation up to the complete destruction of the near-natural vegetation (Kehl, 1985; Ayaşligil, 1987; Tavsanoğlu and Coşgun, 2009; Güneş et al., 2016). The causes of forest disturbance in the mountains are mainly forest fires, illegal logging and grazing (Bond and Keane, 2017). The consequences are thinned forests and even complete Forestry and especially by D.G. Nature conservation and National Parks (DKMP), D.G. Forestry (OGM), etc. activities as well as drastic changes in species composition (Dhaundiyal et al., 2009; Naaf and Wulf, 2007). In intensively exploited stands, more sunlight reaches the ground, which promotes plant species in need of light and suppresses shadow-tolerant plant species (Thysell and Carey, 2001). The preferences of grazing livestock has also caused a change in the composition of the soil flora in heavily used areas. (Wang et al., 2022).

Species that are tasty for animals decline and inedible ones are favoured (Fırıncıoğlu et al., 2008; Ocakverdi and Oflaz, 1999; Papanastasis et al., 2002; Peer et al., 2001; Chebli et al., 2020). Thorny, sticky and hairy plants also spread (Navarro et al., 2006). Large-scale commercial grazing may lead to the extinction of native species (ÇB, 2001).

In Turkiye, only plant communities have been described in phytosociological publications. In contrast, the ecology or structural features of vegetation have hardly been addressed (Kavgaci et al., 2008). There are studies on the distribution of the two main tree species, cedar and fir (Boydak and Çalıkoglu, 2008; Bozkuş, 1988; Sevim, 1955); as far as the middle Taurus forests are concerned, however, scientific work on degradation and its effects on plant communities are missing. Thus, the question to what extent clearing (partial deforestation) and grazing change the functional characteristics and life spectra is still unclear for the middle Taurus Mountains.

For this reason, the effects of clearing and grazing on the changes in the functional characteristics of the vegetation regarding the proportions of grayling sensitive and light - tolerant species were investigated in the current study.

MATERIALS AND METHODS

Study area

The study area, Hortu mountain (540 ha) is around the Karapinar quarter of Alanya district within Antalya province (Figure 1). The project area represents a traditional summer pasture area in the montane to subalpine altitudes between 1550-1800 meters NN in the southern mountain range of the middle Taurus Mountains (Hütteroth, 1959). The local forests in the higher elevations of the Taurus are predominantly mixed forests, dominated by the cedar (*Cedrus libani*) and the fir (*Abies cilicica*). The study area covers a total area of almost 540 ha and is located near the village of Karapınar (Figure 1).

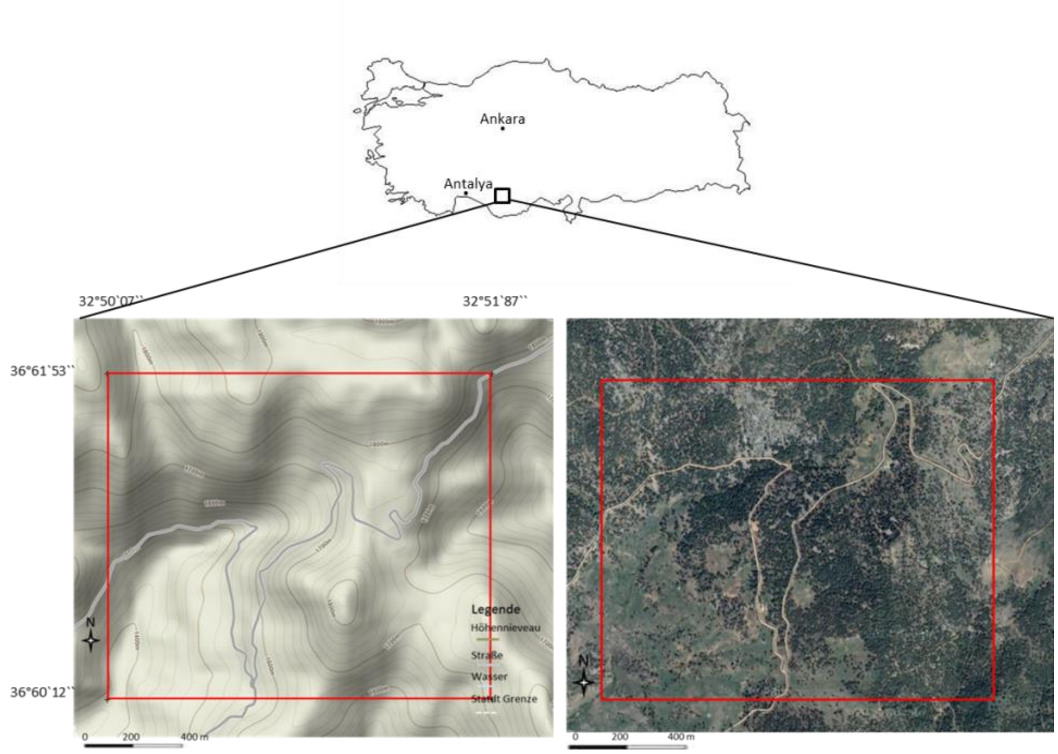

Figure 1: Location of the study area, Hortu Mountain '(red outline) in the central Taurus Mountains
Left: map with contour lines (URL-1), Right: Satellite image with distribution of forests and open landscapes (URL-1).

Figure 1 shows that the terrain is a comparatively small area and contains steep and weakly ebbed parts, but also exposures in all directions (geographic map on the left). The satellite image (right) shows the focal points of the distribution of forests and open landscape parts. It is apparent that there are several areas with small-structured mixtures of both types.

Climate and geology

The climate is continental-Eumediterranean in a mountain form (Kantarcı,1982). Because no direct climate measurements are available for the narrower study area, the climate values were taken from Konya-Hadim Weather Station, the nearest weather station (MGM, 2007, Atalay, 2010, Atalay 2017, Atalay 1988). The Climate values in the study area were as follows: The average temperature during the year was 9.5 C°, in August 26.4 C°, and in January 3.3 C°. The average rainfall was 630 mm during the year and 290 mm in winter.

Geologically, the middle Taurus Mountains consist of limestone, dolomite, sandstone and flysch (Mayer and Aksoy, 1986, Atalay, 2017). The study area itself included limestone, and above all terra rossa, rendzina, colluvia and brown earth (Kuntze et al., 1994).

Methods

The design of the sample is explained before the methodical procedure for the recording itself is addressed.

Sample design

For the vegetation studies, the study area was divided into 6 strata. These were composed of 3 degrees of overlapping and 2 levels of grazing. The thinning variants of Canopy Criteria are closed, half closed and light. The grazing variants of grazing intensity criteria are extensive and intensive. The strata were demarcated and digitised with satellite imagery (Orthophotos) and site inspection (Dierschke, 1994 / Glavac, 1996).

Within a stratum, sample points were systematically measured, in each case 11 sample points per stratum, i.e. 66 sample points on the whole surface of the sample. At each sampling point, strip-shaped sampling areas, whose size was determined by recording the parameters in the tree, shrub or herb layers.

Apart from the respective sample surface sizes, the height frames were indicated for the separation of the 3 layers. The vegetation was distributed according to three different layers (height frame) and corresponding sample sizes. The sample size for the height frame over the 2,5 m (tree layer) is 200 m^2, for the height frame between 1,0 m, and 2,5 m (bush layer) is 100 m^2 and for the height frame equal and smaller then 0,9 m is 50 m^2.

Determination of light and grazing conditions

In the classification of canopy covers significant differences should be considered. To this purpose, the images were taken separately in more or less closed, semi-closed and heavily-dispersed forests. These are referred to as 'closed', 'half-closed' and 'light'. The actual gradations are shown in the results in Table 1.

Since the light represents an, if not the most important, ecological influence factor, the lighting conditions under the canopy were determined for each sampling point by means of fish-eye photos 1 m above the ground. The images were converted from grey values into black and white values according to Brunner (1998) with the program 'Adobe Photoshop 7.0', whereby black objects covering the horizon and white represent the uncovered sky. The 'Winphot 5.0' program calculated the percentage of incident radiation (direct irradiation in %) for each exposure (Ter steege, 1997).

The grazing intensity was separated into the categories 'intensive' and 'extensive' exploitation. Intensively used areas showed increased damage as a result of animal biting. The intensity of conapping was divided into 5 categories (according to Maquardt et al., (2009) (Sweetapple and Burns, 2002; Table 2). Grazing intensity was classified according to stifled intensity into five classes.

Degree of damage for the class '0' (no) is 0, for the class '1' (weak) is 1-25%, for the class '2' (medium) is 26-50%, for the class '3' (strong) is 51-75%, for the class '4' (very strong) is 76-100%.

The classes 0 and 1 are extensive and the classes from 2 to 4 are intensive. Strata with no or predominantly weak bite were categorised as extensively grazed and strata with predominantly medium, strong and very strong bitterness as intensively grazed areas (Veblen et al., 1992).
In order to derive the mean intensity of biting, the average grapevine index was calculated according to (Veblen et al. (1992) with the following formula:).

DBI = (Σ (BI for all samples)) / N calculated.

Where BI = the grave of a sample and N = the number of sample area.

In addition to the bite on the young (<2.50 m) and on the ground vegetation, data were collected on clear footprints. For the footprints, the distances of the animal paths were measured and calculated in terms of the area. In addition, dung spots of cattle, donkeys and horses gave indications of the strength of the grazing. Their numbers were therefore determined on each of the 200 m² test areas.

Images of forest structure, vegetation and geographical parameters

Many trees were damaged by resin extraction. Those trees and the numbers and heights of stumps were determined per sample area. The vegetation was separated into tree, shrub and herb layers on the rectangular areas with the sizes indicated in (Dierschke, 1994).

To assess the tree structure, the crown heights were measured (each as the first green branch) as well as the crown screen areas and the diameters of the trees. In addition, the number and heights of young trees were determined as structural parameters of the forests. Vegetation uptake was performed using the nested plot method (Glavac, 1996).

The recording itself was carried out according to the modified 8-step Braun-Blanquet scale, in which the style is classified according to the categories r, +, 1, 2m, 2a, 2b, 3, 4, 5 (Glavac, 1996). As a result, both rare and dominant species can be detected. In order to be able to statistically calculate and process these scale values, they were transformed as indicated in. In addition, the following geographical parameters were recorded:geographical coordinates, sea level, slope, cover of rocks and exposure.

Data analysis

Values from samples within the same stratum may be correlated with each other and, strictly speaking, may not be netted in variance analysis. Therefore, first the spatial autocorrelations (Legendre, 1993) were determined by regressions of the detected dissimilarities between the distances of each sample by the 'Mantel-Test' (McCune and Grace, 2002) with the with the statistics program PC ORD 6 (McCune and Grace, 2002). (Statistik-Program R 2.15.1 (URL-2) tested. The Bray-Curtis distance was used for the vegetation data and the Euclidean distance for the geographical UTM coordinates. This was preceded by an 'omnibus K-test' for determining normality and a 'Bartlett test' with regard to the equality of variances (Motulsky, 2007).

To determine differences between the groups, the 'Kruskal Wallis test' was used. To check the significance ($p < 0.05$) of the match, the Mann-Whitney U-Test was used with the Each group was compared with the other groups according to the parameters of clearing, grazing index, degree of coverage of the layers of vegetation, and coverage of the soil surface formed by stones.

To visualise the species composition, Canonical Correspondence Analysis (CCA) was performed.

• The first axis by the variable, 'clearing'. Added to this was the description of the three vegetation layers as well as the assessment of the terrain slope, the rocks and the exposure.

• The second axis by the variables 'grazing index', 'cattle fouling', areas of the 'cattle footpaths', number of 'injured trees' and number of "stumps".

For a numerical analysis, the arbitrariness symbols of the Braun-Blanquet scale were replaced by numerical values (Glavac, 1996).

All plant species were compared with the results of the investigations of Doğu (2007) and Deniz and Sümbül (2004), which were obtained in the same area. For the naming of the species, (Davis, 1965-1988) was used.

The ordination process can be used to clarify the relationships between the plant species and the possible gradients of environmental factors (Glavac, 1996). In an indirect ordination, the similarity structure of the floristic space with the species alone is described. CCA (Glavac, 1996) was carried out. In order to reduce the influence of the dominant species, the ordination was transformed with 'power transformation' of the percentage coverages of the species (McCune and Grace, 2002).

Transformed data were used to represent ordination diagrams. These served to correlate the differentiation and similarity of the functional properties and their relationships to the environmental variables of the 6 strata. The CCA was carried out with the statistics program PC ORD 6 (McCune and Grace, 2002).

The functional characteristics of the plant species were determined by means of information in the literature and analysed by means of CCA (Glavac, 1996). This analysis describes the relationships between the functional characteristics of the species and the environmental variables.

The functional characteristics of the plant species were in the foreground reactions to disorders, especially with respect to clearing and grazing. The morphological characteristics, the ingredients, life forms and duration, shadow tolerance (Lososova et al., 2006) and origin were selected as characteristics. Each attribute was assigned several attributes following the example of several authors (Cornellissen et al., 2003, Markesteijn et al., 2007). Overall, there were 25 attributes (Table 6). The importance of the functional attributes in terms of clearing and grazing intensity lies in the ability of the plant species to establish themselves in the ground vegetation. Grazing promotes resistance characteristics (Fırıncıoğlu et al., 2008), which is why the categories ‘prickly’ (Kürschner and Parolly, 2012), ‘rosette’ ‘aromatic’ (Papanastasis et al., 2002) and hairy (Peer et al., 2001) were chosen.

Functional traits were considered for the description of species diversity based on 161 recorded plant species of the ground vegetation in the cedar-fir-forest of the middle Taurus Mountains. This means, descriptions were based on morphological traits such as prickly, hairy, rosettes, and mixed, for example, spiky and rosettes, hairy and rosettes, spiky and hairy, or spiky, hairy and rosettes the following plant species are mixed (Davis, 1965-1988; Pils, 2006; Doğu, 2007).

Additionally, species were distinguished according to their characteristics as mentholated, aromatic or toxic (Akin et al., 2010; Seçmen and Leblebici, 1987), their life form as chamaephyt, therophyt, hemicryptophyt, geophyt, nanophanerophyt, or makrophanerophyt (Davis, 1965- 1988; Doğu, 2007), their lifespan indicated as annual, biennial, or perennial (Davis, 1965- 1988; Dogu, 2007; Babaç, 2004), their shade tolerances (light, semi- shade, shadow) (Davis, 1965- 1988; Doğu, 2007; Babaç, 2004; Ocakverdi and Oflaz, 1999), and according to their origin (Mediterranean, Iranian- Turanian or Euro- Siberian) (Davis, 1965; 1988; Doğu, 2007; Babaç, 2004).

The functional characteristics of the plant species were determined by means of the species trait analysis with the statistics program ‘PC ORD 6’ (McCune and Grace, 2002).

RESULTS AND DISCUSSION

Consequences of clearing and grazing for forest structure, stone cover, browsing and number of species

Between the 6 strata various significant differences were found for the criteria ‘direct radiation’ ‘coverage of the 3 vegetation layers’ as well as the ‘stones’ and furthermore ‘grazing index’, ‘livestock path’ and ‘species number’.

Effects of clearing and grazing on the direct irradiation

The direct radiation varied highly significant between the three degrees of illumination. In the light stands, the dense radiation was almost four times as high as in the closed one. As expected, the grazing had no reliable influence on the radiation, because this was only dependent on the opening of the tree layer, which could not influence the animals. Correspondingly, there was no interaction with regard to the irradiation between the levels of over-scaling and grazing.

Effects of the clearing on the cover values of the tree layer

Equally clear are the differences in the cover values of the tree layer. Despite larger scatters between the individual values, the differences between the strata with the 3 degrees of illumination are still significantly greater than corresponded to the elimination criteria. According to them, closed forests should have >71% overshielding, but light forests should have 10-40%. Here, however, they had values that were even lower, which raises the question if they should have been classified as forests at all. As mentioned in the previous section, the values of grazing intensity did not differ significantly. It is also understandable that no interaction between the two influencing factors occurred.

Effects of clearing on the cover values of the shrub layer

The clearing, compared with the results presented so far (irradiation and tree layer), caused less pronounced, but nevertheless highly assured, differences between the levels of overshadowing with regard to the shrub layer. Because the shrub layer is predominantly accessible for grazing animals, assured differences between grazing intensity levels could have been expected. However, these did not occur, without there being an obvious explanation. It is, however, obvious that the interaction was also not secured.

Effects on cover values of the herb layer

It is apparent that the herbs reacted strongly to the higher light enjoyment in the woodland. Thus, the coverage in the light strata was about 10 times as high as in those under the closed stocks. Contrary to expectations, however, the grazing intensities, as in the case of the shrub layer, had not produced a definite difference. This finding is unexpected, since the cover values should have actually been affected by the grazing due to the requirement of extensive and intensive strength. The fact that this has not occurred can probably only be explained by the fact that the covering of the herbs has been superimposed by shifts in species composition. For example, intensive grazing may have promoted the spread of species that are less attractive to the grazers and have taken over the growth space of the back-fed species.

Effects on the cover values of the stone layer

The surface (visible) covered with stones cannot really be influenced by the clearing or the grazing. The statistical calculations, however, revealed definite differences for the effect of overshielding and grazing and even for the interaction.

First of all, it turns out that the stone cover in the closed parts of the forests is the least, but even lower in the semi-closed forests than in the light. This can only be interpreted considering that the sparse forests increasingly stand on rocky surfaces. Thus, the illumination is not due solely to illegal forest harvesting. Rather, the forests are in places because of light and because

the local conditions do not allow a closed tiller. The assured differences between the levels of cover in the different intensively grazed strata can also not be interpreted easily: it is possible that the grazing animals are more likely to stay where the rock covers only small parts of the topsoil.
On the other hand, the highly assured interaction is even less plausible: for example, the cover values in the closed and sparse forests are lower after intensive grazing, albeit with different degrees of intensity, but higher in half-closed forests.

Impact on the grazing index

Grazing livestock intensity - expressed by the grazing index - was not significantly affected by the elevation.

In contrast, the intensity of grazing led to a highly assured increase in the verb. . In all three shielding variants the biting damage was equally strong and therefore the interaction was not secured. However, the intensity of biting was lowest in the light strata, and so the pseudorandomness of p = 0.052 was narrowly missed.

Effects on the livestock surfaces

Livestock grazing areas could only be measured in a few strata. In fact, they had only been taken up in closed and semi-closed stands in the stretches with intensive grazing. Thus, the amount of data was far too small to be evaluated with variance analysis. Therefore, no statement is possible for this finding.

Effects on the number of species

Species numbers of vascular plants between closed and light forests have doubled most significantly in both extensive and intensive grazing. Only a relatively small number of shadow-bearing species were able to survive in the closed forest. With increasing light enjoyment, the number of species initially increased significantly, but less with further illumination.

The grazing had also brought about a highly assured increase in the number of species, but only a small one, and this was not consistent throughout all forms of clearances rectified. That is probably the reason why a significant interaction could be calculated. Nevertheless, it is difficult to adequately interpret the results of the statistical analyses.

All in all, it can be said that the elimination of the strata was evidently appropriate, because it allowed for a clear distinction between the mean values of the two variables, clearing and grazing.

Demarcation of the stratum

It turns out that the 6 strata can be clearly separated from each other with regard to irradiation and grazing intensity. For example, the values of the plots of the 6th group (light / extensive grazed) are in the lower left graph and the values of the plots in the closed forests are consistently in the right half of the graph. Accordingly, the values of all test areas in intensively grazed strata are arranged in the upper part.

Figure 2 shows the distribution of the strata as a function of the clearing and the grazing. Basis: Canonical Correspondence Analysis (CCA) of vegetation surveys in the cedar-fir-forests in the middle Taurus Mountains.

Here: division of the sample in 6 Straten-groups based on the following variables:
The clearing (Axis 1): Variable shading ((r = -0.898, P = <0.001). The grazing (Axis 2): Variable grazing (r = 0.744, P = <0.001).

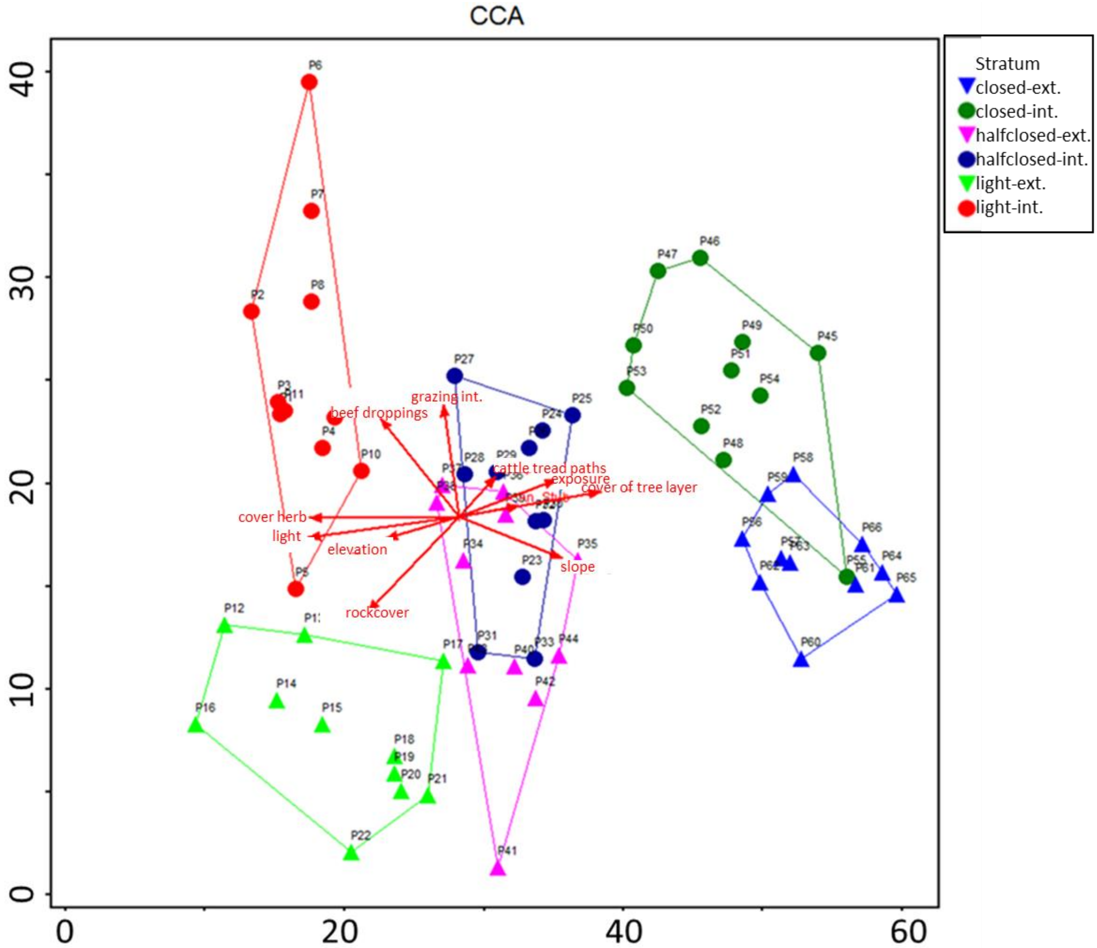

Figure 2: Strata formation according to floristic similarity and environmental variables.

The arrows indicate the spreading tendency of the variables with the two axes: Thus, the coverage of the herb layer increases with higher light intensity. In more inclined terrain, the cattle especially have problems knocking the surfaces. With more intensive grazing, the number of bovine faeces increases. Increased exposure - and this applies to the more frequent northwest orientation - promotes denser forests. Consequently, many plausible connections are apparent. The main correlations are shown in Table 1.

Table 1: Correlations between strata and environmental variables.

stratum			correlationen with
1	Closed	ext.	tree layer covarage

2		int.	tree layer covarage, exposure.
3	Half closed	ext.	Number of stumps, covarage of shrub layer, terrain slope.
4		int.	Grazing index, cattle body spot, injured trees, cattle pathways, number of hours, cover shrub layer.
5	Light	ext.	Irradiation, covering herbaceous layer, covering stones.
6		int.	Irradiation, cover herb layer, bovine faeces sites, grazing index.

The distribution of plant species in the strata is shown in Figure 3.

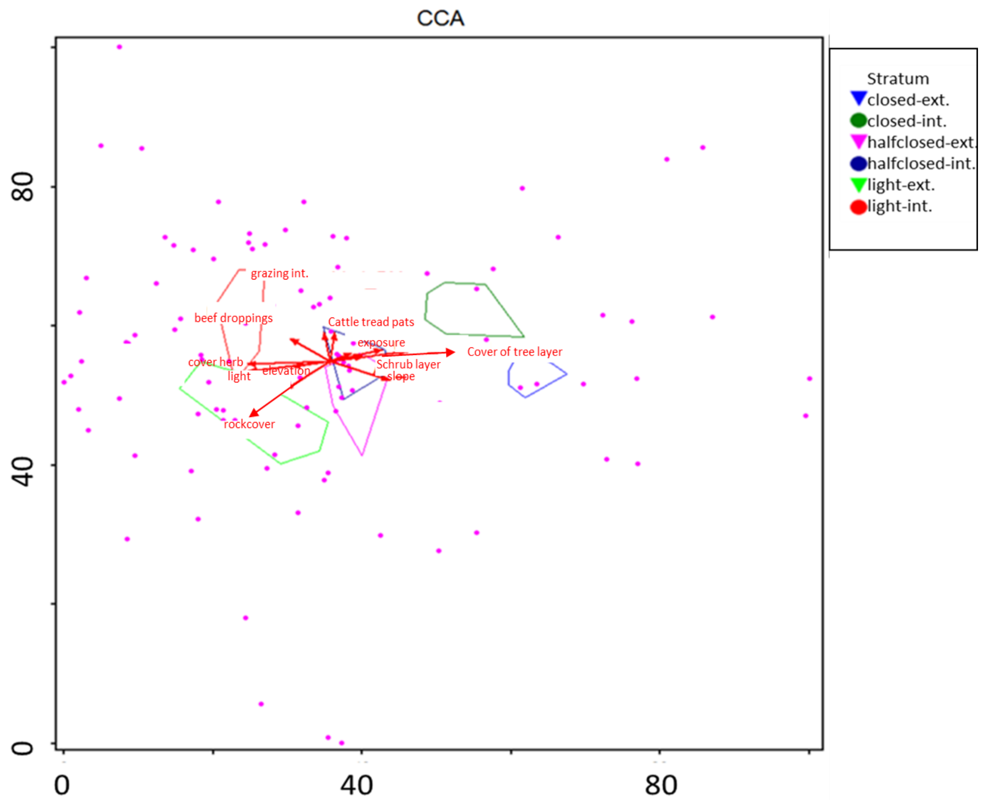

Figure 3: Distribution of plant species in the strata according to the results of CCA. (For abbreviations see Figure 4).

Axis 1: Variable shading ((r = -0.898, P = <0.001).
Axis 2: Variable grazing (r = 0.744, P = <0.001).

The dots in Figure 3 each represent one of the 161 specific plant species and show a wide spread over the entire field of the graph. As a result, on the one hand, the extraordinarily large differences with regard to the need for light or shade of the species are clarified and, on the other hand, the strong dependence of many species on the intensity of grazing becomes apparent.

Dependence of the functional characteristics of clearing and grazing

In Figure 4 to Figure 9, the plant species by life form and duration as well as morphological expression and ingredients, by shadow tolerance and origin in graphs with the axes for illumination and grazing are shown. The distribution of plants according to life form is shown in Figure 4. A distinction was made between chamaephytes (perennial, low Pfl.), therophytes (herbaceous, usually annual Pfl.), hemicryptophytes (creeping), Geophytes (bulbous plants), nanophanerophytes (dwarf shrubs) and mesophanerophytes (shrubs and trees).

The chamaephytes, hemicryptophytes and geophytes were evidently promoted by grazing. They were found mainly in intensively grazed and at the same time clear forest parts.

The dominant plant taxa of Chamaephytes are *Astragalus macrocephalus*, *A. microcephalus* and *Salvia heldreichiana*.

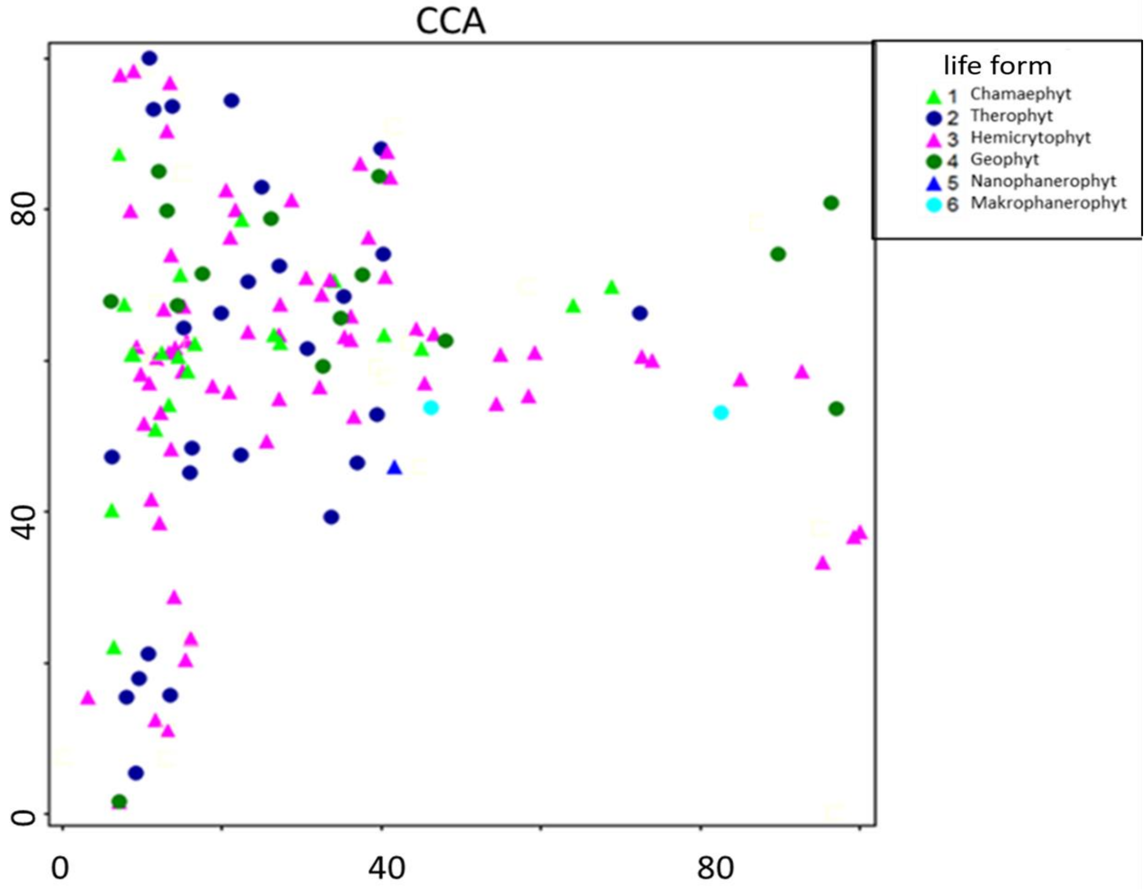

Figure 4: Distribution of plant species according to life form, depending on shading and grazing (see also Figure 2).

Therophytes were found only with low levels of coverage and low frequency. The Hemicryptophytes dominated on the light, intensely grazed areas, and these were, in particular, the dominant plant taxa *Acanthus hirsutus*, *Centaurea urvillei*, *Crepis sancta*, *Minuartia juniperina*, *Phlomis armeniaca*, *Stachys lavandulifolia* and the differential species *Astragalus angustifolius*, *Centaurea kotschyi* as well as *Potentilla* recta with the highest frequency and the highest coverages. Their prevalence was often correlated with the variables grazing intensity, bovine faeces and herb layer cover.

After all, geophytes were common in intensively grazed areas. Dominant plant taxa were *Geranium tuberosum* and *Ornithogalum comosum*.

Another characteristic of plant species in the middle Taurus mountains is the lifespan (Figure 5). One-year-old plants were predominantly found in sparse, partly semi-closed forests.

Biennial plants are the exception. Perennial plant species extend over all areas, but have a focus in the intensively grazed strata and plant species are promoted by grazing. In these stocks dominate the species *Acanthus hirsutus, Astragalus angustifolius, Centaurea urvillei, Crepis sancta* and *Stachys lavandulifolia*.

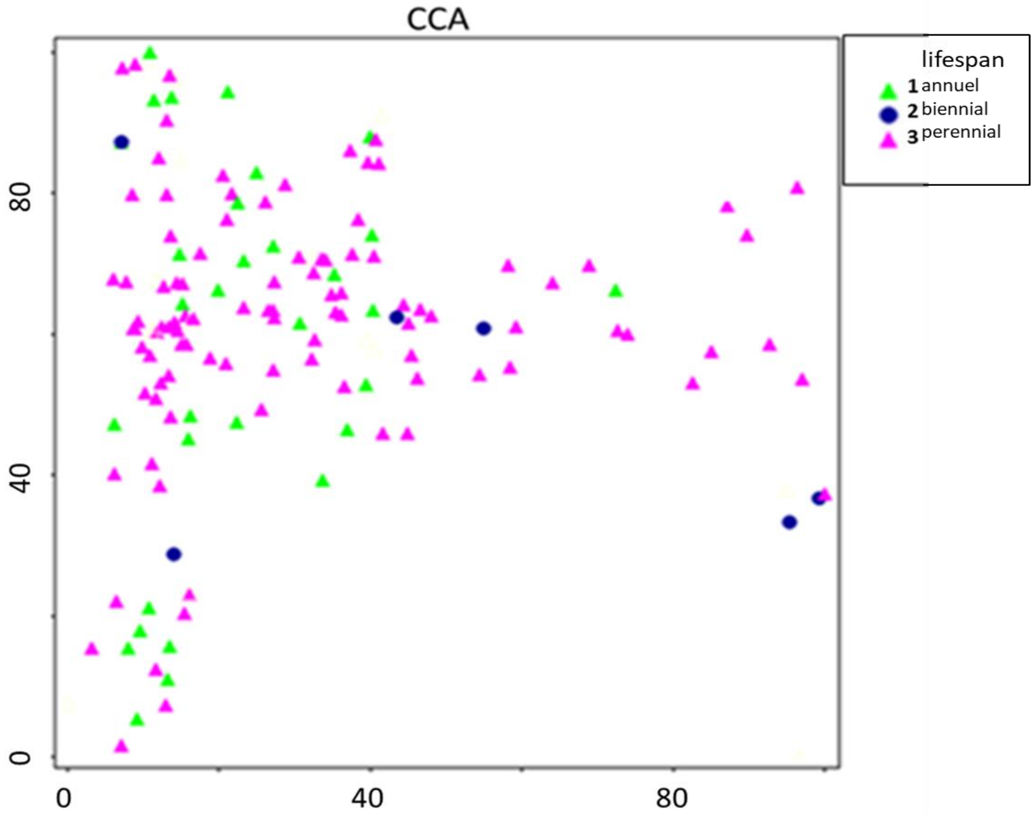

Figure 5: Distribution of plant species according to life, depending on shading and grazing (see also Figure 2).

(3) The occurrence of plants with certain morphological characteristics was also significantly controlled by the main factors of light and grazing. These special features are in the form of spines, rosettes or hair. The corresponding assignments are shown in Figure 6.

Overall, the number of species with special characteristics is lower. Characteristics of spikes and rosettes dominate. More often also plants appeared, which had rosettes and were hairy at the same time. In addition, the occurrence of many species in the lighter areas with simultaneous mean grazing intensity.

The grazing resistant species occur on intensively grazed, sparse stands with the highest frequency and the highest coverages. The dominant plant taxa with hair, spikes and rosettes are *Acanthus hirsutus*, with hair and rosettes *Crepis sancta*. The differential type with thorns and hair is *Centaurea kotschy*, with rosettes *Scorzonera cana* and with hair *Potentilla recta*.

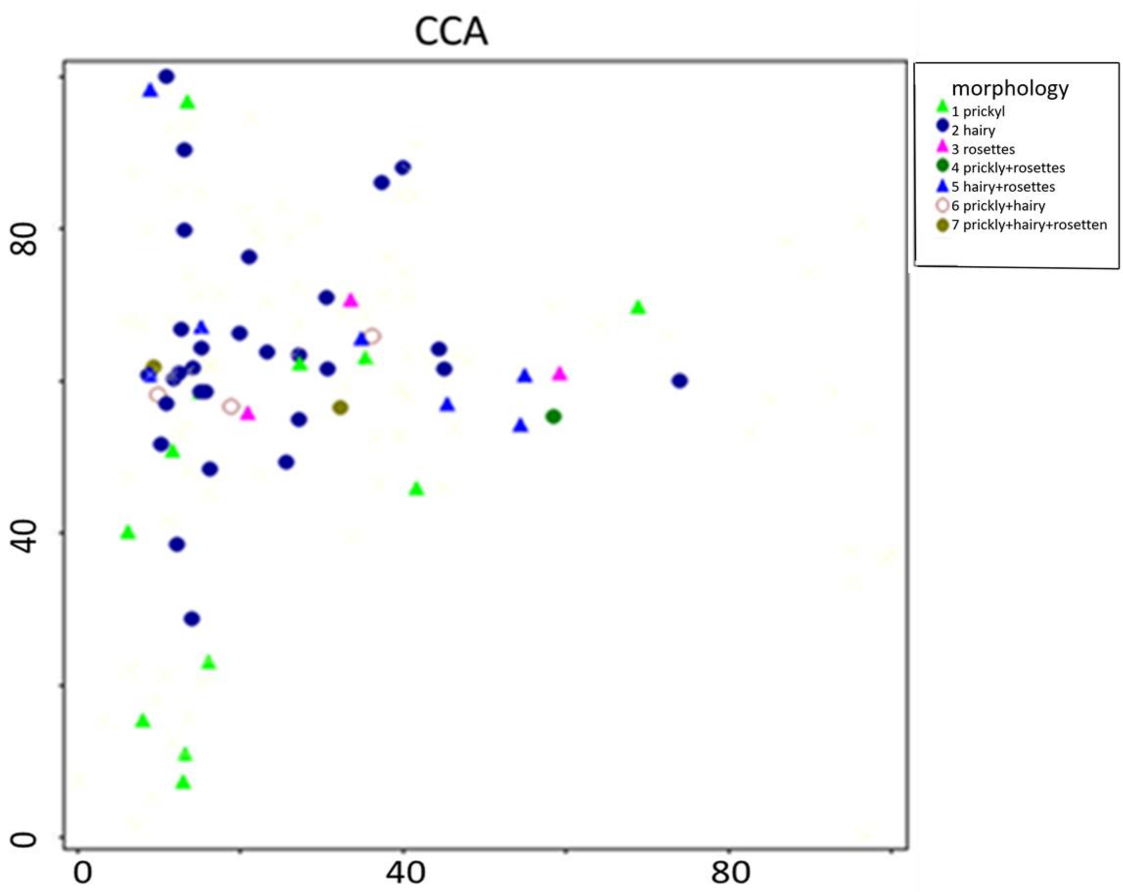

Figure 6: Distribution of plant species according to morphological features depending on shading and grazing. (see also Figure 2).

(4) Plants with specific ingredients are even less abundant (Figure 5 to Figure 9). These are aromatic, menthol-containing and toxic substances, which probably all have the same purpose, namely to deter predators like the grazers.

The number of only approximately 20 species with these characteristics is therefore comparatively small. Most species are found in the area of cleared and intensively grazed strata. These conditions apparently played an essential role because these species were more palatable, their competitors were pushed back by the grazing animals, and they were able to profit from the reduced competition.

A typical plant species with aromatic substances is *Phlomis armeniaca*. The dominant plant taxa with menthol is *Stachys lavandulifolia*. Toxic plants are the dominant and differential plant taxa *Acanthus hirsutus*, *Euphorbia kotschyana* and *Ranunculus demissus*.

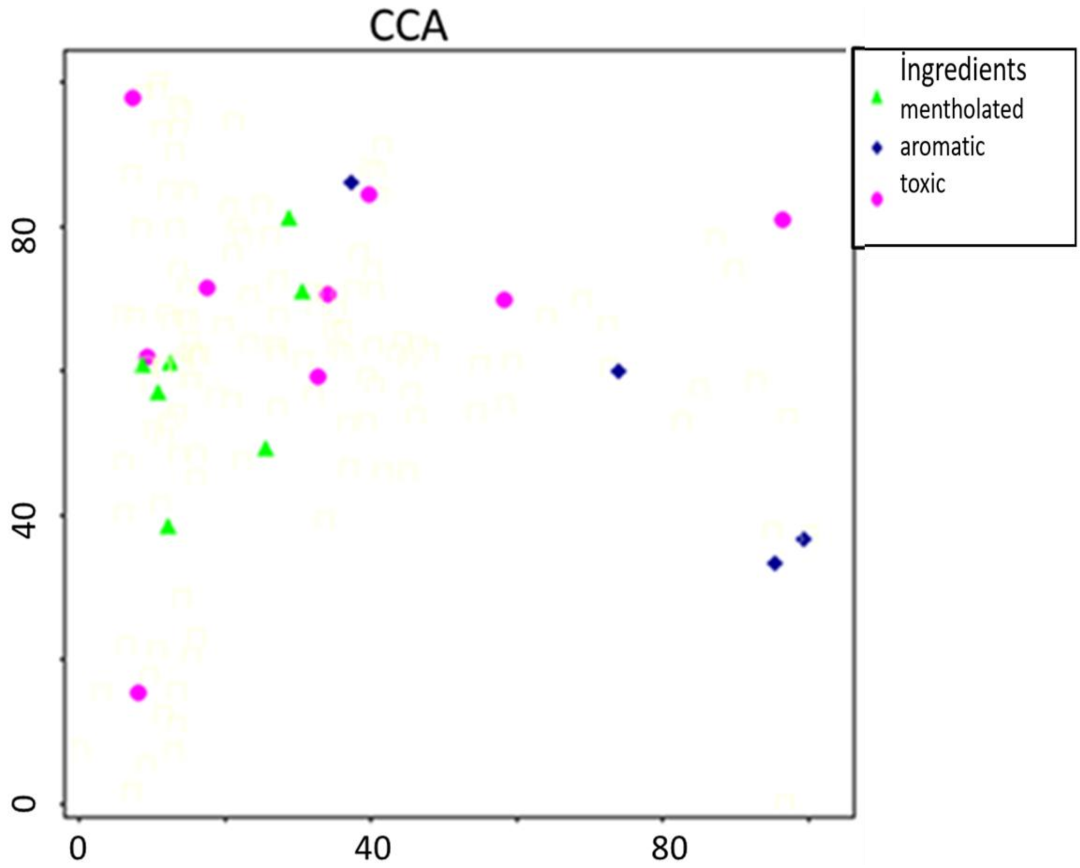

Figure 7: Dtribution of plant species according to ingredients depending on shading and grazing (see also Figure 2).

(5) In terms of shadow tolerance (Figure 8) almost all species are represented again. The limitation 'almost' results from the fact that not all species were aware of the need for light or the ability to bear shadows.

The light-requiring plant species dominated the study area significantly. This is clearly illustrated in Figure 8. More than half of the species were found in sparse strata, both under weaker and stronger grazing. There is also a relatively wide transition zone in semi-closed forests. However, grazing intensity apparently did not play a major role there and especially in the closed forests.

Dominant light-requiring species are *Acanthus hirsutus, Bromus japonicus, B. tectorum, Crepis sancta, Geranium tuberosum, Phlomis armeniaca, Stachys lavandulifolia, Stipa arabica* and *Valeria dioscoridis.* They are almost only in the light stocks. Partial shade tolerant is *Pilosella piloselloides*. In these strata, however, there are also species that are more in need of light, such as *Arabidopsis thaliana, Bromus sterilis, Centaurea pichleri* and *Scorzonera incisa*. Shadow tolerant are *Doronicum orientale* and *Lathyrus digitatus*. In closed stocks, also *Abies cilicica* and *Lathyrus laxiflorus* dominate.

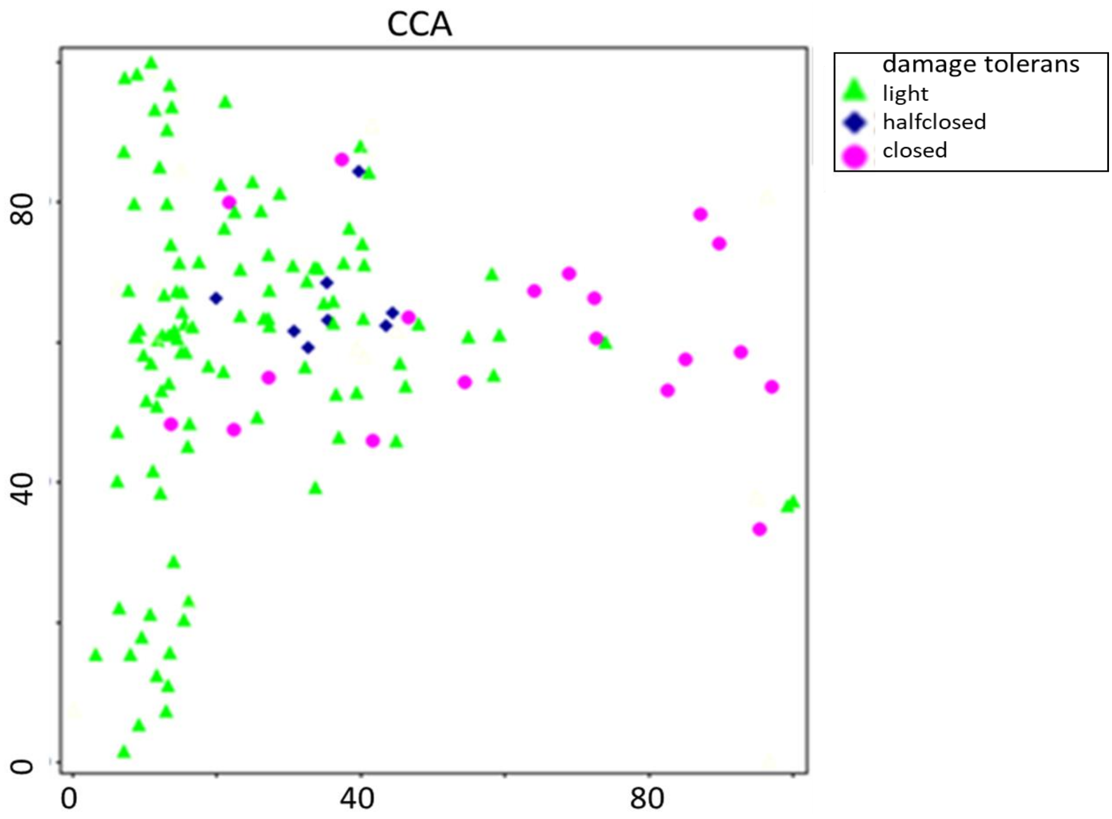

Figure 8: Distribution of plant species for shade tolerance depending on shading and grazing (see also Figure 2).

(6) The flora of Turkiye (Davis, 1965-1988) is characterised by the large geographical and thus floristic neighbouring regions. With regard to the geographical origin of the plant species in the middle Taurus Mountains, 49% of Mediterranean, 46% Iranian-Turanian and 5% Euro-Siberian species were found in intensively grazed, clear areas. However, not all plant species in the study area were able to prove their geographical origin. The proportion of endemic species in the study area is very low at 4.6% compared to the flora of Turkiye, at more than 30%.

After the distribution in Figure 9, the species from the two more important flora areas are common, especially in sparse forests. However, the Mediterranean species continue to exist in closed forests compared to the Iranian-Turanian.

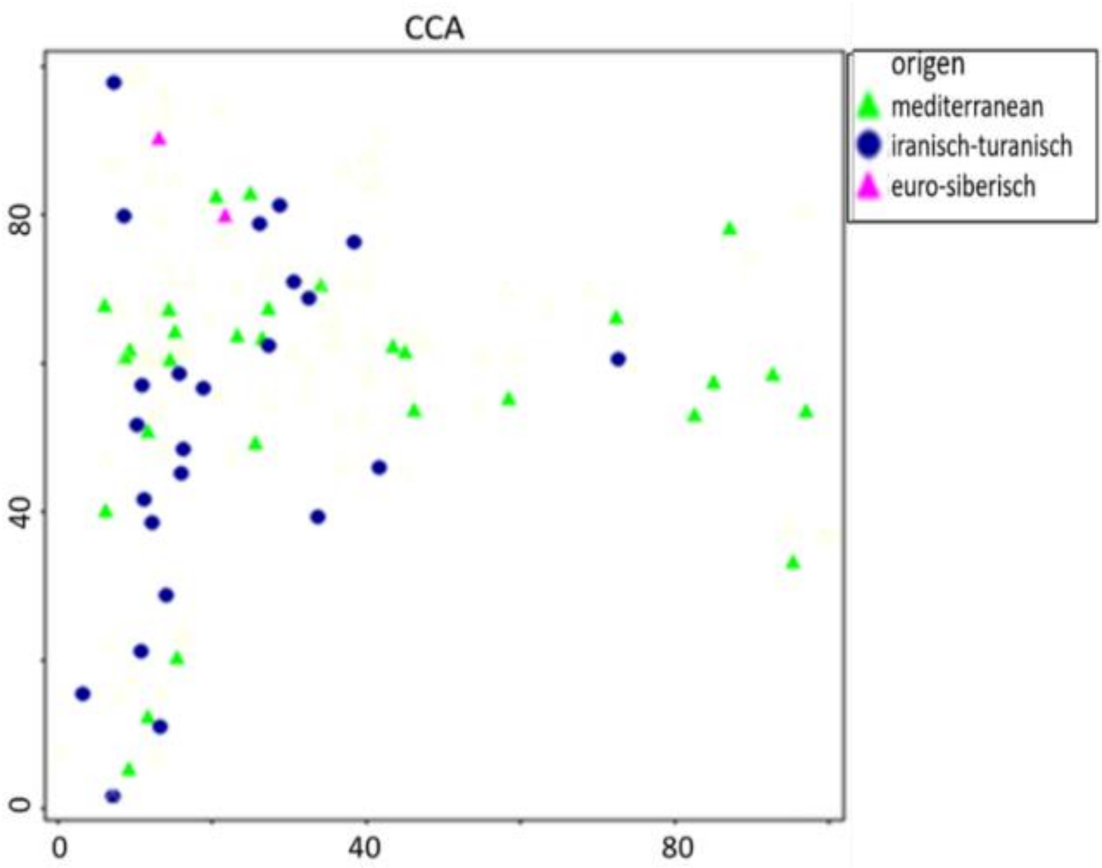

Figure 9: Distribution of plant species according to the geographical origin depending on shading and grazing. (For further explanations, see Figure 2).

CONCLUSION

Near-natural vegetation is disturbed and fragmented by human activity in Mediterranean ecosystems (Savas 1941; Kehl 1985; Ayaşligil 1987; Mayer and Aksoy 1986; Özden et al., 2004). Especially the areas of the cedar-fir forests are used as summer pastures are affected (Ayaşligil, 1987).

The results of the present study indicate that the factors clearing and grazing have significant effects on soil vegetation and forest structure. First, the spatial variation of the plant species was examined, whereby the phytosociological and structural analysis was in the focus. Variations were made from these, and the environmental factors were related to the intensity of the clearing and grazing.

Comparing extensively and intensively grazed areas, heavy grazing was found to promote hemicryptophytes and chamaephytes (Fırıncıoğlu et al., 2008; Böcük et al., 2009). In these perennial plants with periodic sprout reduction, the renewal buds are near the ground and are often protected by soil and plant parts (Frey and Lösch 2004). This gives them the opportunity to grow and rejuvenate after intensive grazing.

In contrast, the Therophytes in particular decreased (Kürschner and Parolly, 2012). They only occurred in extensively grazed areas. There, the dominant species *Anthemis pestalozzae*, *Minuartia sclerantha, Trigonella tenuis* and the differential species *Ziziphora capitata* have been established. If thermophytes are to be promoted and protected, intensive grazing must be avoided.

Grazing has a significant impact on annual species. On extensively grazed areas, which are characterised by exposed rocks that are not favourable for grazing, the species with a short life span and low propagation potential dominate (Frey and Lösch, 2004). However, these species are easily destroyed by grazing, usually before they have formed seeds. So, if one-year species are to be promoted in the stocks, intensive grazing needs to be avoided.

By contrast, perennial plant species are promoted by grazing (Fırıncıoğlu et al., 2008; Böcük et al., 2009; Papanastasis et al., 2002). In these stands, *Acanthus hirsutus, Astragalus angustifolius*, *Centaurea urvillei, Crepis sancta, Salvia vergaul* and *Stachys lavandefolia* have the highest frequency and highest coverage. They are enduring, have a high dispersal potential, are resilient and therefore dominate in intensively grazed areas (Frey and Lösch, 2004).

Due to their morphological properties, spiny, thorny and hairy species are spared in intensively grazed areas, as they are not tasty for grazing animals. In addition, it comes in these areas to a dominance of species with rosettes as these are poorly accessible to the grazers and therefore hardly eaten.

Studies on the ingredients of plants have shown that aromatic, menthol-containing and poisonous species are also promoted on intensively grazed areas, as the grazing animals do not like them (Fırıncıoğlu et al., 2008).

Tasty taxa are always preferred and their proportion is thus reduced. It would be desirable for some forests to be left to natural processes in the future so that conclusions can be drawn regarding the ability of individuals to regenerate and changes in species composition.

However, considering the environmental conditions in the forests, there are also benefits in terms of the light factor. Open areas, due to the artificially created by clearing and logging, result in more favourable lighting conditions for the ground cover, whereby light-requiring species are promoted.

In the semi-closed and closed stands, these species hardly occur, but dominate semi-shade and shadow-tolerant species. In order to conserve biodiversity in the middle Taurus Mountains and similar regions, the advantages and disadvantages of open areas should be taken into account in order to achieve a balance of light-polluting species (Vajari et al., 2012; Naaf and Wulf, 2007), semi-shade and shadow-tolerant species.

Spreading of *Phoresia ssp*. of plant seeds by grazing animals can lead to the outgrowth of certain plant species, such as *Geranium tuberosum* and *Scorzonera cana* (Yavuz et al., 2012; Papanastasis et al., 2002).

However, in order to counteract a decline in species that are sensitive to grazing, it would make sense to stop intensive grazing in general.

Surprisingly, more endemic species were found in intensively grazed areas than in extensively grazed areas, but most of them were prickly, thorny or toxic species.

The forests in the research area were studied during the summer period by the declining population with significantly fewer animals than before. Therefore, it could be assumed that the burden on the landscape by humans and animals has fallen sharply and the forests have started to recover.

This is not the case yet. Illegal or uncontrolled Grazing and logging still cause problems. Although measurements to tackle illegal use are currently discussed, one major problem is still the inadequate implementation of laws and other regulations. On inquiry, it turned out that adequate control by the state authorities is missing. Awareness of nature conservation is largely lacking in the population and should be promoted.

Meanwhile, the state authorities have recognized that they can no longer ignore the needs of the population and their way of life. This is important because otherwise the local population will continue the illegal uses to meet their basic needs. However, the practices so far have not been effective enough. In this sense, forestry and nature protection activities should be controlled in a long-term and environmentally sensitive manner.

Regarding the management of landscapes in the middle Taurus Mountains, it is recommended to protect the diversity of plants and structures. Especially the rare species *Cephalanthera rubra* and *Orchis anatolica* and the endemic species in the middle Taurus Mountains *Cyclamen cilicium* have an economic value. Generally, they are collected and sold illegally. These species should be protected and used sustainably as soon as possible, and measures taken to preserve them in the region.

Several species have been classified by hazard category according to IUNC (2001). For them, therefore, rapid protection is particularly urgent. The assessed species by risk category in the study area are as follows:

The species for the threat category ‘CR=highly endangered’ is *Acantholimon ulicinum,* for the threat category ‘EN=endangered’ is *Silene lycaonica,* for the threat category “NT=To assume danger” are *Cyclamen cilicium, Ranunculus demissus, Veronica dichrus*, for the threat category ‘VU=early warning’ is *Centaurea kotschyi.*

Furthermore, not only the habitats of many rare species are to be secured, but also the competition from invasive species is to be reduced for the native plant communities. Examples of these invasive species are *Centaurea urvillei, Minuertia juniperina, Minuertia scleranthus.* Reducing grazing and the consequent is expected to help preserve and restore the forests. In order to reduce degradation, grazing pressure in the herds of goats in particular should be stopped, since they are responsible for the greatest damage to the vegetation.

Undoubtedly, a better understanding of these relationships is important for the future management of the forests and for the assessment of the nature conservation potential and is likely to contribute to decision-making issues such as the design of grazing.

FUNDING STATEMENT

The study received no financial support.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

ETHICS COMMITTEE APPROVAL

This study does not require any ethics committee approval.

REFERENCES

Akın, M., Demirci, B., Bagcı, Y., Baser. H.C.K., (2010). Antibacterial activity and composition of the essential oils of two endemic *Salvia* sp. from Turkey. *African Journal of Biotechnology*, 9(15): 2322- 2327.

ATALAY, İ. (1988). Vegetation levels of the Taurus Mountains of Mediterranean region in Turkey. *Ege Coğrafya Dergisi*, *4*(1).

Atalay, İ. (2010). Uygulamalı klimatoloji. *META Basım Matbaacılık Hizmetleri, Bornova/İzmir*.

Atalay, İ. (2016). A new approach to the land capability classification: Case study of Turkey. *Procedia Environmental Sciences*, *32*, 264-274.

Atalay, İ. (2017). Türkiye Jeomorfolojisi. *Meta Basım, İzmir*.

Ayaşlıgil, Y., (1987). Der Köprülü Kanyon Nationalpark: Seine vegetation und ihre beeinflussung durch den menschen. lehrstuhl für landschaftsökologie, Technische Universität München-Weihenstephan.

Babaç M.T., (2004). Possibility of an ınformation system on plants of south-west Asia with particular reference to the Turkish plants data service (TUBIVES), *Turkish Journal of Botany*, 28(1-2):119-127.

Bond, W. J., Keane, R.E., (2017). Fires, ecological effects of, *Reference Module in Life Sciences*: 11S. doi:10.1016/B978-0-12-809633-8.02098-7.

Boydak, M., Çalıkoğlu, M., (2008).Toros sedirinin (*Cedrus libani* A.Rich) Biyolojisi ve Silvikültürü. OGEM- Vakfi. Ankara.

Bozkuş, F., (1988). Toros Göknari (*Abies cilicica* Carr.) nin Turkiye`deki Dogal Yayilisi ve Silvikültürel Özellikleri. Orman Genel Müdürlüğü, Ankara.

Böcük, H., Türe, C., Ketenoglu, O., (2009). Plant diversity and conservation of the north-east Phrygia region under the impact of land degradation and desertification (Central Anatolia, Turkiye). *Pakistan Journal of Botany*. 41(5): 2305-2321.

Brunner, A., (1998). A light model for spatially explicit forest stand models, *Forest Ecology*, 107(1-3):19-46.

ÇB, (2001).Çevre Bakanlığı. Ulusal biyolojik çeşitlilik stratejisi ve eylem planı (UBSEP), Ankara.

Chebli, Y., El Otmani, S., Chentouf, M., Hornick, J. Bindelle, J., Cabaraux, J.F., (2020).Foraging behavior of goats browsing in Southern Mediterranean Forest Rangeland, *Animals*10(2):196;doi:10.3390/ani100201196.

ÇOB, (2004). Çevre ve Orman Bakanlığı. Türkiye Çevre Atlası. Ankara (webdosya.cbs.gov.tr/db/ced/icerikler/turkyecevreatlas--20180514084340.pd).

Cornelissen, J. H. C., Lavorel, S., Garnier, E., Díaz, S., Buchmann, N., Gurvich, D. E., ... & Poorter, H. (2003). A handbook of protocols for standardised and easy measurement of plant functional traits worldwide. *Australian journal of Botany*, *51*(4), 335-380.

Der Heijden, M.G.A., Pausas, J.G., Poorter, H., (2003). Handbook of protocols for standardised and easy measurement of plant functional traits worldwide. *Australian Journal of Botany,* 51(4): 335–380.

Davis, P.H., (1965-1988). Flora of Turkiye and the East Aegean Islands. 1-9, Edinburgh University Press.

Deniz, I. G., Sümbül, H., (2004). Flora of the Elmalı Cedar Research Forest (Antalya/Turkiye). *Turk. J. Bot, 28*(6): 529-555.

Dhaundiyal, N., Agarwal, P., Kumaiyan, M., Sah, P., (2009). Species richness in an Oak Forest of Indian Himalaya with reference to canopy gap. *New York Science Journal*, 2(4): 5-16.

Dierschke, H., (1994). Pflanzensoziologie, Grundlagen und Methoden. Ulmer, Stuttgart.

Doğu, S., (2007). Tufan Dağ, Çorak Dağı ve Turanşah Dağı (Karaman) Florası. Selcuk Üniversitesi, Fen Bilimleri Enstitüsü Konya PHD Thesis.

Fırıncıoğlu, H.K., Sahin, B., Seefeldt, S., Mert, F., Hakyemez, B.H., Vural, M., (2008). Pilot study for an assessment of vegetation structure for Steppe Rangelands of Central Anatolia. *Turkish journal of Agriculture and Forestry* 32(5): 401- 414.

Frey, W., Lösch, R., (1998). Lehrbuch der Geobotanik: Pflanze und Vegetation in Raum und Zeit..Gustav Fischer Verlag. Stuttgard, ISBN3-437-25940-7.

Glavac, V., (1999). Vegetationsökologie: grundfragen, aufgaben, methoden. Gustav Fischer Verlag. Jena, Stuttgard, Lübeck, Ulm; ISBN: 978-3-437-35060-3.

Güneş, Y., Albert, R., Jürgen, H., (2016). Change of land use in the Turkish Taurus Mountains. *Journal of the Faculty of Forestry Istanbul University (JFFIU)* 66.(1): 184-197.

Hütteroth, W.D., (1959). Bergnomaden und Yaylabauern im Mittleren Kurdischen Taurus Heft 11 Marburger Geographische Schriften.

IUCN, (2001). IUCN Red List Categories and Criteria: Version 3.1, iucnredlist.org/resources/categories-and-criteria.

Kantarcı, M.D., (1982). Türkiye sedirleri (*Cedrus libani* A. Richard) ve dogal yayılış alanında bazı ekolojik ilişkiler. *Istanbul Üniversitesi Orman Fakültesi Dergisi* 32(2): 113- 198.

Kavgacı, A., Carni, A., Urban, S., (2008). Bitki sosyolojisi çalışmalarında kullanılan sayısal metotlar ve bazı bilgisayar programları. Süleyman Demirel Üniversitesi *Orman Fakültesi Dergisi*, 9(2): 188- 201.

Kehl, H., (1985). Zur Mediterranen Flora und Vegetation der SW- Türkei und Problematik der Vegetationsentwicklung am Beispiel einer Küstennahen Siedlung bei Antalya. Die Technische Universität Berlin, Dissertation.

Kuntze, H., Roeschmann, G., Schwerdtfeger, G., (1994). Bodenkunde. 5., Neu Bearbeitete und Erweiterte Auflage, Stuttgart, Verlag Eugen Ulmer, ISBN (3-8252-8076-4).

Kürschner, H., Parolly, H., (2012). The Central Anatolian Steppe, In Eurasian Steppes. ecological problems and livelihoods in a Changing World. Springer Netherlands, 149-171. DOI:10.1007/978-94-007-3886-7_4.

Legendre, P., (1993).Spatial Autocorrelation: Trouble or new paradigm *Ecology* 74(6): 1659-1673.

Lososova, Z., Chytry, M., Kuhn, I., Hajek, O., Horkova, V., Pysek P., L., Tıchy., (2006). Patterns of plant traits in annual vegetation of man-made habitats in Central Europe. *Perspectives in Plant Ecology, Evolution and Systematics* 8(2): 69-81.

Maquardt, S., Marquez, A., Boillot, H., Beck, S.G., Mayer, A.C., Kreuzer, M., Alzerreca, A.H., (2009). Intensity of browsing on trees and shrubs under experimental variation of cattle stocking densities in southern Bolivia. *Forest Ecology and Management*, 258(7): 1422-1428.

Markesteijn, L., Poorter, L., Bongers, F., (2007). Light dependent leaf trait in 43 tropical dry forest tree species. *American Journal of Botany* 94(4): 515-525.

Mayer, H., Aksoy, H., (1986). Wälder der Türkei. Stuttgart: Gustav Fischer Verlag, Stuttgart, New York.

McCune, B., Grace, J.B., (2002). Analysis of ecological communities, *Journal of Experimental Marine Biology and Ecology*, 289(2).

MGM,(2007). Meteoroloji Genel Müdürlüğü. Hadim Meteoroloji İstasyonu Müdürlüğü İklim Verileri,.

Motulsky. H. J., (2007).Prism 5 Statistics Guide. GraphPad Software.

Naaf, T., Wulf, M., (2007).Effects of gap size, light and herbivory on the herb layer vegetation in European beech forest gaps. *Forest Ecology and Management* 244(1-3): 141-149.

Navarro, T., Alados, C.L., Cabezudo, B., (2006).Changes in plant functional types in response to goat and sheep grazing in two semi- arid shrublands of SE Spain. *Journal of Arid Environments* 64(2): 298- 322.

Ocakverdi, H., Oflaz, S., (1999).The plant Sociology and ecology of the Upper Göksu Catchment Area (Hadim-Konya) and Environs, *Turkish Journal of Botany* 23(3): 195-209.

Özden, S., Atmış, E., Menemencioglu., (2004). Negative effects of recent unplanned expansion on highland ecosystems in Turkiye. *Mountain Research and Development* 24(4): 303-306.

Papanastasis, V.P., Kyriakakis, S., Kazakis, G., (2002). Plant diversity in relation to overgrazing and burning in mountain Mediterranean ecosystems. *Journal of Mediterranean Ecology* 3(2-3): 53-63.

Peer, T., A. Millinger, J., Gruber, P., Hussain, F., (2001). Vegetation and altitudinal zonation in relation to the impact of grazing in the steppe lands of the Hindu Kush Range (N-Pakistan). *Phytocoenologia* 31(4): 477-498.

Pils, G., (2006). Flowers of Turkey. A photo guide, ISBN: 20309

Savas, K., (1941). Die Waldweide in der Türkei. ihr gegenwärtiger umfang und ihre künftige wirtschaftliche sowie rechtliche regelung. M. Dittert & Co Dresden.

Seçmen, Ö., Leblebici, E., (1987). Yurdumuzun zehirli bitkileri. Ege Üniversitesi, Fen Fakültesi, Kitap Serisi No:103, Izmir.

Sevim, M., (1955).Lübnan Sediri`nin (*Cedrus libani* A. Rich.) Türkiye`deki tabii yayılışı ve ekolojik şartları. Orman Umum Müdürlügü, Yayın No:143 Ankara.

Sweetapple, P.J., Burns, B.R., (2002). Assessing The Response of Forest Understoreys to Feral Goat Control With and Without Possum Control. Department of Conservation, Science for Conservation:201, New Zealand. ISSN:1173-2946 doc.govt.nz/globalassets/documents/science-and-technical/sfc201.pdf.

Tavsanoğlu, Ç., Coşgun, U., (2009). Köprülü Kanyon Milli Parkı'nda (Antalya) Bulunan bazı maki türlerinin gelişme formu üzerinde keçi otlamasının etkisi. *Ekoloji* 18(72): 74-80.

Ter Steege, H., (1997). Wınphot 5.0. A. programme to analyze vegetation indices, light and light quality from hemispherical photographs (Manual). Tropenbos-Guyana Reports Utrecht University.

Thysell, D.R., Carey, A.B., (2001). Manipulation of density of *Pseudotsuga menziesii* canopies: preliminary effects on understory vegetation. *Canadian Journal of Forest Research* 31(9): 1513-1525.

URL-1. Google Earth (2013). Google Earth 2011-2015.

URL-2. R- Development Core Team 2012. R: A Language and Environment for Statistical Computing. Vienna: R foundation for Statistical Computing (R-project.org;(2014).

Vajari, K.A., Jalilvand, H., Pourmajidian, M.R., Espahbodi, K., Moshki, H., A., (2012). Effect of canopy gap size and ecological factors on species diversity and beech seedlings in managed beech stands in Hyrcanian forest. *Journal of Forestry Research* 23(2): 217-222.

Veblen, T.T., Mermoz, M., Martin, C., Kitzberger, T., (1992). Ecological impacts of introduced animals in Nahuel Huapi National Park, Argentina. *Conservation Biology*, 6(1): 71- 83.

Wang, G., Mao, J., Fan, l., Ma, X., Li, Y., (2022). Effects of climate and grazing on the soil organic carbon dynamics of the grasslands in Northern Xinjiang during the past twenty years, *Global Ecology and Conservation*, doi.org/10.1016/j.gecco.2022.e02039.

Yavuz, T., Sürmen, M., Töngel, M.Ö., Avag, A., Özaydın, K.A., Yıldız, H., (2012). Amasya mera vejetasyonlarının bazı özellikleri. *Tarım Bilimleri Arastırma* 5(1): 181-18.