COMPARATIVE STUDY OF STEPPIC GRASSLANDS PRODUCTIVITY AND GRAZING PRESSURE IN BABADAG AND CASIMCEA PLATEAUS

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Abstract. *Determining the production and forage quality of a permanent grassland is essential for establishing the optimal stocking rate in order to preserve the biodiversity and the traditional landscape. The paper presents an assessment of the productivity of steppic grasslands from the two large geographical entities of the ROSCI 0201 North Dobrogean Plateau protected area, respectively Babadag and Casimcea Plateaus. The grasslands from the Babadag Plateau have undergone an accelerated process of degradation in the last 50 years due to the very large share of sheep and goats, almost 90% of the total grazing livestock, that graze all year round except for the days when the soil is covered with a layer of snow. The grasslands from the Casimcea Plateau have generally maintained their productivity for the last 45-50 years as the structure of the vegetal layer has been better preserved, a situation due to the 27% of the total livestock of cattle and horses that were maintained in the stable in the cold season. Currently, the grazing pressure exceeds carrying capacity of these steppic grasslands for 5.5 times in Babadag and 5 times in Casimcea, which is why it is necessary to balance the structure and number of livestock, expand fodder crops in arable land and implement more efficient management measures.*

Keywords: steppic grasslands, feed productivity, carrying capacity, biodiversity conservation

1. Introduction

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The permanent grasslands from ROSCI0201 The North Dobrogean Plateau are mostly included in the natural habitat of community interest 62C0* Ponto-sarmatic steppes.

The vegetation of these steppic grasslands was studied from a phytosociological point of view, resulting in two synthesis papers for the Babadag Plateau [2] respectively for the Casimcei Plateau [4]. In these papers, the steppic grassland vegetation, respectively the permanent grasslands, were mostly included in *Festuco – Brometea* Class, *Festucetalia valesiacae* Order, *Festucion rupicolae* and *Pimpinello - Thymion zygoidi* Alliances, that can be assimilated with habitat type 62C0 *.

The studies of the steppic grasslands vegetation were carried out within the POIM Project "Integrated Management of the North Dobrogean Plateau (MiPoNoDo)", MySMIS code 11696. The studies of Babadag and Casimcea grasslands conducted in the summer of 2019 allowed the reevaluation of their productivity, after almost 45 -50 years, based on floristic surveys according to a new method [5].

Having available the data on livestock for 2018, for the 20 villages within the studied area, it was possible to calculate the current stocking rate for grasslands to be compared with the optimal one from the Babadag and Casimcea plateaus.

These studies are a support for the scientific substantiation of the integrated management measures of this site of great scientific, landscape, economic and multicultural importance [7].

2. Material and methods

To evaluate the productivity turnover of the steppic grasslands from the two geographical formations, the Babadag and Casimcea plateaus, we started by analyzing two synthesis papers regarding the grassland phytocoenosis [2,4].

Between June and July 2019, 67 floristic surveys were conducted on the field on 100 sq m plots [1]. The surveys were accompanied by soil samples taken at a depth of 0-10 cm, samples being analyzed according to the methodology proposed by Florea et al. [3].

The floristic surveys were carried out according to the Klapp - Ellenberg method with the direct percentage appreciation of the species' participation in the vegetal layer, which further facilitates our statistical interpretation.

The data regarding areas of permanent grasslands and livestock for 2018 (cattle, sheep, goats and horses) for 20 villages from our research area were obtained from the Tulcea County Agricultural Directorate.

From the total number of villages from our area of interest, 13 of them (Babadag, Ceamurlia de Jos, Cerna, Ciucurova, Dorobanţ u, Horia, Izvoarele, Jurilovca, Mihai Bravu, Nalbant, Pecineaga, Sarichioi and Slava Cercheză) are located in Babadag Plateau, the rest of the villages (Baia, Beidaud, Casimcea, Dăeni, Ostrov, Stejaru and Topolog) being located in Casimcei Plateau (Figure 1).

Fig. 1. Research area, with Babadag Plateau at North and Casimcei Plateau at South

The evaluation of the productivity of the grasslands (grazing land value and fodder production) was made according to the new method based on floristic survey [5].

The assessment of the grazing land value and the stocking rate depending on the production, the optimal grazing period and the necessary feed for 1 LU (Livestock Unit), respectively 65 kg of grass per day of grazing, was carried out after Maruşca et al. [5].

The evaluation of the productivity of the grasslands based on floristic survey allowed us to capitalize on some older studies of grassland vegetation and compare them with more recent ones in order to assess the evolution in time of floristic and economic parameters.

3. Results and discussions

The results on the main physical and agrochemical characteristics of the soils in the studied areas are presented in Table 1.

Table 1. Average physical and agrochemical characteristics of the soils of 62C0* habitat type from the Babadag and Casimcea Plateaus for June – July 2019

Specification	*UM*	*Babadag (B) (26 surveys)*			*Casimcea (C) (41 surveys)*			*Differences C - B*	
		Min.	*Max.*	***Avg.***	*Min.*	*Max.*	***Avg.***	*+, -*	*%*
Soil scheleton	%	0.3	39.8	**6.18**	0	49.9	**7.27**	+ 1.09	118
pH	ind.	6.29	8.27	**7.59**	5.33	8.32	**6.72**	- 0.87	89
Carbonates	%	0	34.1	**9.86**	0	27.9	**2.56**	- 7.30	26
Humus	%	1.66	15.87	**6.52**	2.15	9.78	**6.33**	- 0.19	97
N	%	0.144	0.708	**0.350**	0.141	0.540	**0.330**	- 0.02	94
P_{AL}	mg/kg	4	42	**12.15**	5	137	**16.63**	+ 4.48	137
K_{AL}	mg/kg	133	696	**263**	99	541	**223**	- 40	88

From these data it is found that the soils in Casimcea, compared to Babadag, have a higher skeleton content (2-25 mm), with a more acidic pH reaction due to the much lower carbonate content.

The explanation is found in the geological substrate composed in Casimcea, especially of "green shales" (green siltite, fine sandstones and quartz-feldspars, hydrothermal quartz, paragnaise, rhyolite, etc.) and in Babadag from Upper Cretaceous blankets (fine sandstone limestones, microsparitic and silicified, fine calcarenite, etc.), on which basic reaction soils were formed. The total humus and nitrogen content is about the same with a slight increase of 3-6% in Babadag. In contrast, mobile phosphorus is 37% higher and mobile potassium 12% lower in the soils of Casimcea than Babadag.

Generally speaking, the soils in the two locations are weakly acidic to neutral basic, very poor in mobile phosphorus and medium to well-supplied in mobile potassium. On these soils a diversified herbaceous vegetation has developed, used currently mainly by grazing (overgrazing) (Table 2).

The floristic composition of the 67 floristic surveys is made up of 98 more important species, of which 21 species from the Poaceae family, 14 species from the Fabaceae family and 63 species from other botanical families.

Table 2. Comparative situation of the floristic composition and productivity of the 62C0* Ponto - Sarmatic steppes natural habitat from the Babadag and Casimcea Plateaus

SPECIES	*Participation %*		*Differences C - B*		*Index*	
	Babadag	*Casimcea*	*+ , -*	*%*	*F**	*M***
1	**2**	**3**	**4**	**5**	**6**	**7**
POACEAE						
Festuca valesiaca	15.08	27.12	+12.05	180	5	3
Botriochloa ischaemum	21.12	7.93	-13.19	38	3	0
Stipa capillata	4.46	4.59	+0.12	103	3	0
Cynodon dactylon	1.77	6.54	+4.77	369	6	2
Stipa ucrainica	1.50	0.10	-1.40	7	3	0
Poa bulbosa	1.27	1.78	+0.51	140	6	1
Festuca callieri	0.77	0.29	-0.48	38	5	2
Koeleria splendens	0.69	0.24	-0.45	35	5	3
Bromus tectorum	0.65	0.54	-0.12	82	5	2
Agropyron cristatus	0.58	1.02	+0.45	178	7	5
Poa angustifolia	0.46	0.00	-0.46	0	7	5
Stipa tirsa	0.46	0.00	-0.46	0	3	0
Bromus hordeacens	0.12	0.32	+0.20	275	3	0
Chrysopogon gryllus	0.38	0.90	+0.52	235	4	7
Hordeum murinum	0.15	0.00	-0.15	0	5	3
Bromus inermis	0.04	0.00	-0.04	0	8	8
Koeleria braevis	0.00	0.85	+0.85	0	5	3
Bromus riparius	0.00	0.07	+0.07	0	3	0
Dactylis glomerata	0.00	0.02	+0.02	0	9	8
Lolium perenne	0.00	0.02	+0.02	0	9	8
Phleum phleoides	0.00	0.02	+0.02	0	6	4
FABACEAE						
Medicago falcata	0.62	0.05	-0.57	8	7	6
Astragalus onobrychis	0.38	0.02	-0.36	6	5	4
Medicago lupulina	0.19	0.12	-0.07	63	8	3
Onobrychis viciifolia	0.12	0.10	-0.02	85	8	8
Astragalus glaucus	0.08	0.20	+0.12	254	5	4
Coronilla varia	0.08	0.00	-0.08	0	1	0
Trifolium arvense	0.08	0.00	-0.08	0	4	2
Trifolium campestre	0.08	0.00	-0.08	0	7	2
Vicia cracca	0.04	0.00	-0.04	0	7	6
Vicia vilosa	0.04	0.00	-0.04	0	7	6
Lathyrus pratensis	0.04	0.00	-0.04	0	7	6
Coronilla scorpioides	0.04	0.00	-0.04	0	3	0
Lotus corniculatus	0.00	0.20	+0.20	0	6	2
Medicago minima	0.00	0.07	+0.07	0	7	1
OTHER FAMILIES						
Artemisia austriaca	2.81	4.78	+1.97	170	2	0
Thymus pannonicus	3.81	4.49	+0.68	118	4	2
Teucrium chamaedrys	3.19	0.76	-2.44	24	3	0

Euphorbia sequeriana	2.15	1.73	-0.42	80	1	0
Marrubium peregrinum	1.69	0.15	-1.55	9	3	0
Convolvulus cantabricus	1.69	0.07	-1.62	4	3	0
Achillea pannonica	1.65	0.95	-0.70	58	6	5
Teucrium polium	1.38	0.63	-0.75	46	3	0
Crataegus monogyna	1.23	2.07	+0.84	168	3	0
Thymus zygioides	1.23	1.12	-0.11	91	4	1
Eryngium campestre	1.19	1.83	+0.64	153	3	0
Sanguisorba minor	1.12	0.41	-0.70	37	6	3
Potentilla argentea	1.04	0.95	-0.09	92	4	2
Fragaria viridis	0.77	0.10	-0.67	13	4	1
Plantago lanceolata	0.65	0.59	-0.07	90	6	1
Achillea coarctata	0.62	0.78	+0.17	127	6	3
Adonis vernalis	0.62	0.00	-0.62	0	1	0
Inula ochulus-christi	0.58	0.07	-0.50	13	3	0
Euphorbia glareosa	0.46	0.02	-0.44	5	1	0
Dianthus nardiformis	0.42	0.73	+0.31	173	3	0
Daucus carota	0.38	0.00	-0.38	0	6	5
Potentilla recta	0.35	0.10	-0.25	28	5	2
Galium humifusum	0.31	0.37	+0.06	119	5	2
Sedum hildebrandti	0.27	0.93	+0.66	344	3	0
Carpinus orientalis	0.23	0.00	-0.23	0	3	0
Asperula cynanchica	0.19	0.15	-0.05	76	3	0
Pimpinella tragium	0.19	0.12	-0.07	63	3	0
Taraxacum serotinum	0.19	0.05	-0.14	25	5	2
Agrimonia eupatoria	0.19	0.02	-0.17	13	3	0
Ajuga chamaepitys	0.19	0.02	-0.17	13	3	0
Cruciata pedemontana	0.15	0.24	+0.09	159	3	0
Potentilla pedata	0.15	0.02	-0.13	16	4	2
Euphorbia nicaënsis	0.12	0.49	+0.37	423	1	0
Cichorium intybus	0.12	0.22	+0.10	190	5	6
Salvia nutans	0.12	0.02	-0.09	21	4	2
Convolvulus arvensis	0.08	0.10	+0.02	127	7	6
Xeranthemum annuum	0.08	0.10	+0.02	127	3	0
Echinops ruthenicus	0.08	0.05	-0.03	63	3	0
Reseda lutea	0.08	0.02	-0.05	32	3	0
Haplophyllum suaveolens	0.08	0.00	-0.08	0	3	0
Chondrilla juncea	0.04	0.27	+0.23	698	3	0
Alyssum alyssoides	0.04	0.10	+0.06	254	3	0
Berteroa incana	0.04	0.10	+0.06	254	3	0
Adonis flammea	0.04	0.02	-0.01	63	3	0
Valerianella lacusta	0.04	0.02	-0.01	63	3	0
Alyssum hirsutum	0.04	0.00	-0.04	0	3	0
Ajuga laxmanii	0.04	0.00	-0.04	0	4	2
Herniaria glabra	0.00	0.54	+0.54	0	3	0
Centaurea diffusa	0.00	0.37	+0.37	0	4	4
Rosa pimpinellifolia	0.00	0.29	+0.29	0	3	0

Hieracium pilosella	0.00	0.17	+0.17	0	4	1
Scleranthus perennis	0.00	0.12	+0.12	0	3	0
Erodium cicutarium	0.00	0.10	+0.10	0	3	0
Achillea setacea	0.00	0.07	+0.07	0	6	3
Carduus nutans	0.00	0.07	+0.07	0	3	0
Herniaria hirsuta	0.00	0.05	+0.05	0	3	0
Anthemis ruthenica	0.00	0.05	+0.05	0	3	0
Hieracium bauhinii	0.00	0.05	+0.05	0	4	1
Echium vulgare	0.00	0.05	+0.05	0	4	3
Galium verum	0.00	0.05	+0.05	0	5	4
Linum austriacum	0.00	0.02	+0.02	0	3	0
Sanguisorba officinalis	0.00	0.02	+0.02	0	7	5
Scleranthus annuus	0.00	0.02	+0.02	0	3	0
Gaps in vegetation	**16.61**	**19.05**	+2.44	115	X	X
Total non-forage species (F1-3)	**47.27**	**29.83**	-17.44	63	X	X
Total forage species (F4-9)	**36.12**	**51.12**	+15.00	142	X	X
Grazing (Pastoral) Value (PV)	**20.59**	**29.13**	+8.54	141	X	X
Feed quality assessment	**Week**	**Mediocre**	X	X	X	X
Average phytomass index (M)	**1.03**	**1.42**	X	X	X	X
Useful grass production (GM t/ha)	**2.06**	**2.84**	+0.78	138	X	X
Stocking rate (LU/ha)	**0.17**	**0.24**	+0.70	141	X	X
Stocking rate evaluation	**Degraded**	**Very week**	X	X	X	X

*) F = Feed value index

**) M = Useful green mass index

In Casimcea there are over 19% gaps in vegetation, 30% participation of non-forage species and over 51% forage species. In Babadag we have almost 17% gaps, over 47% participation in the vegetal layer with non-forage species and only 36% forage species that can be consumed by livestock.

As a result of this structure, from the interpretation of data resulted that the grazing (pastoral) value in Casimcea is 41% higher than in Babadag, the production of useful phytomass (fodder) higher by 38% and obviously the optimal stocking rate is 41% higher.

It can be seen that the grazing value of 21-29 is weak to mediocre, the production of green fodder mass is 2.1 - 2.8 t/ha which allows an optimal stocking rate of 0.17 - 0.24 LU/ha, indicating degraded to very weak grasslands.

One of the main causes of the very low level of productivity of steppic grasslands in addition to the local environmental conditions with drier climate and lack of water in the soil is overgrazing and the absence of the most basic maintenance works (cleaning of grasslands, fertilization, etc.).

In order to evaluate the "grazing (pastoral) pressure" we used the data regarding the surface of the grasslands and livestock for the 20 villages from our area of interest, establishing the current stocking rate (LU/hectare) (Table 3).

Table 3. Surface of permanent grasslands, livestock and stocking rate in the Babadag and Casimcea Plateaus

Specification	*UM*	*Babadag*	*Casimcea*	*Differences C - B*	
				+, -	%
Permanant grasslands	**ha**	**15,410**	**14,020**	-1,390	91
Grazing livestock(individuals):					
Cattle	no.	1,767	4,968	+ 3,201	281
Sheep	no.	66,943	65,893	- 1,050	98
Goats	no.	25,556	21,495	- 4,601	84
Horses	no.	241	1,081	+ 840	448
Livestock Unit (nr. LU)					
Cattle (x 0,75)	no.	1,325	3,726	+ 2,401	281
Sheep (x 0,14)	no.	9,372	9,225	- 1,470	98
Goats(x 0,14)	no.	3,578	3,004	- 574	84
Horses (x 0,80)	no.	193	865	+ 672	448
Total Livestock (LU)	no.	**14,468**	**16,815**	**+ 2,347**	**116**
Livestock structure (% LU)					
Cattle	%	9.2	22.2	+ 13.0	241
Sheep	%	64.8	54.9	- 9.9	85
Goats	%	24.7	17.8	- 6.9	72
Horses	%	1.3	5.1	+ 3.8	392
Stocking Rate	**LU/ha**	**0.94**	**1.20**	**+ 0.26**	**128**

From these data it results that from the total area of grasslands of 29,430 hectares in 2018, approx. 52% belonged to Babadag and 48% to Casimcea Plateau. If the areas of grasslands are substantially equal, the livestock as species are quite differentiated.

Thus, in Casimcea there are over 3,000 LU more cattle and horses and over 2,000 fewer sheep and goats out of the almost 17,000 LU respectively 2,300 LU higher than Babadag which has 14,500 LU in total.

This structure in favor of cattle and horses that better respect the grazing and housing season in Casimcea compared to the more numerous sheep and goats that graze all year round in Babadag, is one of the important factors of more severe degradation of productivity of grasslands in Babadag, compared to Casimcea.

The stocking rate for 2018 was 28% higher in Casimcea (1.2 LU/ha) compared to Babadag (0.94 LU/ha).

The long-term evolution of the productivity of assessed grasslands has also benefited the grasslands in the Casimcei Plateau, although the soil conditions seem to be more favorable in the Babadag Plateau (Table 4).

Table 4. Evolution of grasslands productivity and stocking rate from the Babadag and Casimcea Plateaus

Specification	*UM*	*Babadag Plateau*				*Casimcei Plateau*			
		1970	*2019*	*Dif.+,-*	*%*	*1975*	*2019*	*Dif.+,-*	*%*
Grazing (pastoral) Value (PV)	ind.	31.9	20.6	-11.3	65	19.2	29.1	+9.9	151
Feed production	t/ha	4.47	2.06	-2.41	46	2.62	2.84	+0.22	108
Optimal stocking rate	LU /ha	0.37	0.17	-0.20	46	0.22	0.24	+0.02	108
Current stocking rate	LU /ha	x	0.94	x	x	x	1.20	x	x
Current difference from optimal	+, -	x	+0.77	x	x	x	+0.96	x	x
	%	x	553	x	x	x	500	x	x

It is observed that the pastoral value in Babadag decreases by 11 and the fodder production decreases by 2.4 t/ha GM (Green Mass) in the period 1970-2019 and in Casimcea it increases by 10, the fodder production being almost constant in the period 1975-2019.

Comparing the current stocking rate with the optimal one resulting from the calculation, it is found that the stocking rate is 5.5 times higher in the Babadag Plateau and 5 times higher in the Casimcei Plateau, compared to the carrying capacity of these steppic grasslands.

Similar analyzes performed according to the same methodology in the Măcinului Mountains, located north of the Babadag plateau, showed a stocking rate approximately 2 times higher than the current carrying capacity [6].

These results raise a serious alarm about the need to reduce pastoral pressure on grasslands, by reducing livestock or providing fodder for the current livestock by expanding perennial and annual fodder crops in arable land.

Conclusions

(1). The permanent grasslands of the Order *Festucetalia valesiacae* with the Alliances *Festucion rupicolae* and *Pimpinello – Thymion zygioidi* which is assimilated with Habitat 62C0* Ponto-sarmatic steppes from the Babadag and Casimcea Plateaus are currently in a very advanced stage of degradation, floristic and economic.

(2). The main cause of the degradation of the pastoral value and the production of useful phytomass is the overgrazing which is 5.5 times in Babadag and 5 times in Casimcea, over the current carrying capacity.

(3). The grasslands from the Babadag Plateau, with 89.5% sheep and goat from total livestock ststructure, have degraded at a faster rate in the last 45-50 years, compared to Casimcea with 72.7% sheep and goats in the total LU, where productivity and biodiversity have suffered less.

(4). Reducing the pastoral pressure to the estimated level of 0.17 LU/ha in Babadag and 0.22 LU/ha in Casimcea and cultivating annual and perennial forage plants in arable lands to ensure the necessary feed for existing livestock in the 20 territorial administrative units (villages), is the most viable solution for the future.

(5). Balancing the structure between sheep, goats and cattle and a minimum of management measures on these grasslands, would contribute to the conservation of biodiversity and protection of the environment and landscapes.

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