CONTRIBUTIONS TO THE EVALUATION OF THE PRODUCTIVITY OF GRASSLANDS ON SANDBANKS AND MICRO-DEPRESSIONS OF THE DANUBE DELTA

Daniyar MEMEDEMIN[*,], Teodor MARUȘCA[*,***], Cristina I. PORR[*], Cristina C. COMȘIA[*]**

[*]Research-Development Institute for Grasslands, 5 Cucului St., Brasov, 500128, Romania
[**] Ovidius University of Constanta, 1 Universitatii Alley, 900470, Constanta, Romania
*** Corresponding author e mail: maruscat@yahoo.com

Abstract

Having a special conservation importance due to the difficult vegetation conditions, the permanent grasslands on the sandbanks and micro-depressions of the Danube Delta suffer a constant depreciation in terms of the quality and quantity of green mass. Comparative analysis of historical data sets with more recent data shows a continuous and constant decrease in quality and productivity. Thus, if the average green mass production in the 1960s was about 4.9 t/ha and the pastoral value index was 34, in the 1990s the grasslands of the Festucion vaginatae and Puccinelion limosae alliances, the most valuable from grazing point of view, recorded a production of 2.9 t/ha MV and a pastoral value index of 22, highlighting a 41% reduction in green mass production, respectively a 65% decrease in pastoral value. Overgrazing until the 1990s, followed by uncontrolled extensive grazing in the following period, are among the most important factors that led to the sharp degradation of these grasslands.

Keywords: Danube Delta grasslands, pastoral value, green mass and milk production

INTRODUCTION

An emblematic area due to the biodiversity elements hosted, the Danube Delta also represents the area where we can find a unique mix of human communities (Boja & Popescu 2000, Petrescu 2007, Gastescu 2009, Parau 2012, Doroftei & Covaliov 2013, Tănăsescu & Constantinescu 2020, Rus et al. 2025). This heterogeneity also leaves its mark on the economic activities in the area, many of which are still carried out according to ancestral rules. Fishing, reed harvesting, animal husbandry are some of these activities that still use techniques and methods inherited from the ancestors, thus ensuring the sustainability and charm of the place (Titov & Chiselev 2015, Covaliov et al. 2023). Accelerated development in recent times brings with it the abandonment of traditional practices and the adoption of modern and more efficient methods, which however have a significant impact on biodiversity and, implicitly, on human communities. (Doroftei et al. 2011, Giosan et al. 2013, Vaidianu et al. 2015).

An activity with a significant negative effect on biodiversity in general and on vegetation in particular is overgrazing (Wang et al. 2020, Gonzales & Ghermandi, 2021, Wang et al. 2023). Previous studies on this subject highlight the negative

effect of overgrazing on the grasslands of the Danube Delta (Trifanov et al. 2018, Marusca et al. 2024, Memedemin & Marusca 2024) and recommend the need to respect both the principles of scientific grazing and traditional practices, especially the optimal stocking rate, to preserve the remarkable biodiversity of this area (Torok et al. 2016, Fynn & Jackson 2022, Marusca et al. 2024, Shipley et al. 2024).

In order to assess the impact of human activities on natural habitats, the study of changes in the structure of the specific composition of vegetation can be a very useful tool (Josefsson et al. 2009, Zinnen et al. 2021). Thus, the comparative analysis between historical data and the current situation can be of real help in understanding the phenomena and in more efficient management of natural or anthropogenic induced changes. (Kapfer et al. 2017, Straubinger et al. 2023).

MATERIAL AND METHOD

To evaluate the productivity of grasslands located on the sandbanks and in the micro-depressions of the Danube Delta, we analyzed the paper "Natural Meadows in the Danube Delta" prepared by Viorel Vasiu, Mircea Pop and Flavius Floca and published in 1963 in the journal "Hidrobiologia" of Romanian Academy Publishing House.

The aforementioned paper presented the study on the vegetation of the Danube Delta grasslands carried out between 1958 and 1960. The study presents the situation before the collectivization of agriculture, during which time there was a better balance between green mass production and animal loading as a result of respecting traditional animal husbandry practices in the delta area. The working method used by the authors for the study of grassland vegetation was that of the Zurich-Montpelier Floristic School, using the Braun Blanquet evaluation scale for scoring the abundance-dominance of species in the vegetal layer. (Cristea et al. 2004).

In the evaluated study, for each floristic survey in the mentioned work, the species were grouped into grasses, legumes and species from other botanical families. Also, vegetation cover degree, vegetation height, station data, location and type of landuse were presented. For some surveys, productivity elements were also, empirically, estimated.

Primary data from the most important surveys in terms of the quality of the vegetation layer on the 7 sandbanks (Fig. 1) formed the basis for the evaluation of green fodder production and pastoral value according to the method developed by Maruşca. (2019, 2022).

Assessment of the productivity elements using information from the studied material allowed calculating the optimal animal load and determining milk production, as the

main economic parameters for grasslands (Marușca et al. 2018) for the period in which the initial study was conducted.

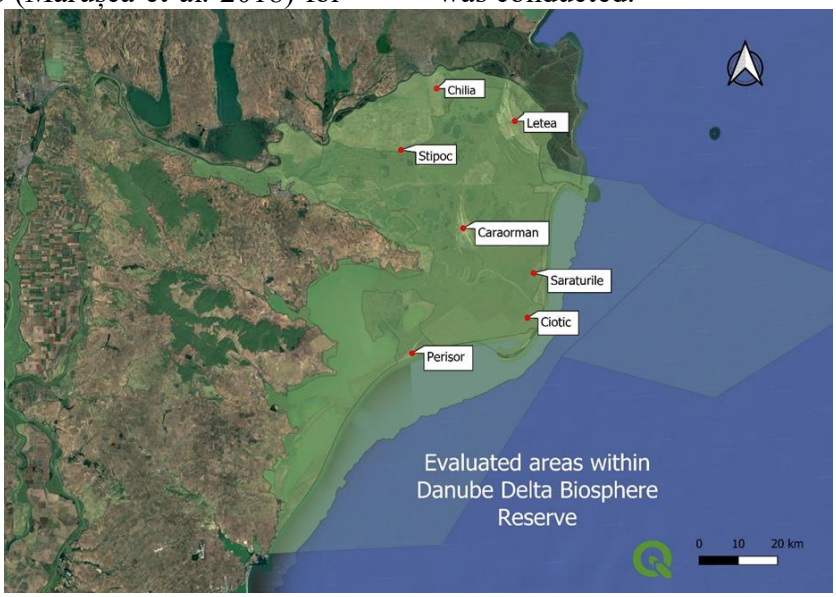

Fig. 1 – Areas studied within the DDBR

RESULTS AND DISCUSSIONS

The database with the information necessary for productivity calculations allowed the evaluation, based on the floristic survey, of 6 grassland plant associations on 7 sandbanks, also analyzing the micro-depressions from this areas (Table 1).

From the evaluated study, information was extracted for 66 floristic surveys, in which an average of 21 species of cormophytes were recorded. The most plant species, 34 in number, were recorded in the grasslands with sandy soils in micro-depressions and the fewest, only 8 species in the Association with *Salicornia herbacea*. Vegetation coverage was quite low, on average 68%, with limits between 39% in the Association with *Festuca vaginata* to 90% in the Association with *Agrostis stolonifera*. The table 1 presents only species with fodder value that are consumed by animals, totaling an average of 52% participation (76.5% of the total), the rest being represented by species without fodder value.

The average green fodder production (GFY) of the 6 evaluated plant associations is just over 5 tons per hectare, being able to provide fodder for only 0.60 LU/ha in 130 days of optimal grazing duration. The highest production of 10.53 t/ha GFY with 1.25 LU/ha was evaluated in the association with *Agrostis stolonifera* and the lowest of 1.65 t/ha GFY in sandy grasslands in microdepressions with an animal load of barely 0.2 LU/ha, for the same duration of the grazing season.

Table 1

Productivity of the main grassland plant associations (A1-A6) on the sandbanks and micro-depressions of the Danube Delta, in 130 days of grazing season (average numbers for 1958-1960 period)

Specification	A_1	A_2		A_3	A_4	A_5	A_6	Average
Location	C,L	Cio,L,P,S		C,Chi,L,Sti	P	Chi,L,P,S,Sti,	L,S,Sti	
Nr. of relevees (∑)	5	24		8	10	10	9	66
Avg. number of sp.	30	34		11	30	11	8	21
Vegetation coverage (%)	39	41		90	66	85	85	68
Forage sp participation (%)	27	20		73	59	55	78	52
Poaceae (%)								
Agropyrum elongatum		0.2			47.8	0.2		8
Agropyrum repens				1.2				0.2
Agrostis stolonifera				56.3		4.1	0.1	10
Apera spica venti	0.1	9.6		2.8		0.2		2.1
Bromus comutatus		0.1			0.1			0.1
Bromus tectorum	0.7	6.3						1.1
Crysopogon gryllus	0.1							0.1
Cynodon dactylon	1.0	2.3		1.3	1	2.0	0.1	1.2
Festuca arundinacea					0.1	0.1		0.1
Festuca vaginata	23.2	0.1						3.8
Poa angustifolia		0.1						0.1
Poa bulbosa		0.2						0.1
Poa pratensis					0.1			0.1
Puccinellia distans				4.3	5.7	40.8	6.5	9.5
Fabaceae (%)								
Lotus corniculatus				0.1				0.1
Medicago falcta	1.3	0.2			0.1			0.2
Medicago lupulina		0.1						0.1
Medicago minima	0.2	0.1			0.1			0.1
Melilotus albus	0.1	0.3		0.4	0.2	0.1		0.2
Trifolium fragiferum				5.6				0.9
Vicia craca	0.4							0.1
Other plant fam.(%)								
Carex distans				0.1	2.4	0.1		0.4
Daucus carota					0.1			0.1
Echium vulgare	0.2							0
Juncus gerardi				1	0.9	7.2		1.5
Plantago lanceolata		0.2			0.1			0.1
Plantago media				0.1				0.1
Salicornia herbacea							71.8	11.9
Harmful plants participation (%)	12	21		17	7	30	7	16
Green Fodder (GFY t/ha)	2.21	1.65		10.53	9.13	3.54	3.43	5.08
Optimal load	LU/ha	0.26	0.20	1.25	1.08	0.42	0.41	0.60
	%	44	33	208	180	70	68	100
Pastoral Value (ind. PV)	15.57	11.45		55.70	37.78	39.85	37.07	32.84
Milk production	L/ha	1240	890	4350	2950	3110	2890	2570
	%	48	35	169	115	121	112	100

LEGEND

Location
C = Caraorman
L = Letea
S = Sărăturile
Sti = Stipoc
Chi = Chilia
Cio = Ciotic
P = Perișoru

Grassland plant species associations
A_1 - Association with *Festuca vaginata*
A_2 - Micro-depression grasslands with sandy soils
A_3 – As. with *Agrostis stolonifera*
A_4 – As. with *Agropyrum elongatum*
A_5 – As. with *Puccinellia distans*
A_6 – As. with *Salicornia herbacea*

The average pastoral value (PV) with an index of almost 33 (poor) can provide 2570 liters of milk/ha. The minimum is represented by a PV index of 11.45 with 890 l/ha in the microdepression plant association and the maximum of 55.7 PV index with 4350 l/ha, 5 times more, in *the Agrostis stolonifera* association.

Of the described grassland associations, the one with *Elymus giganteus* from the Sărăturile, Letea and Caraorman marine sand dunes was omitted, due to the fact that the vegetal layer coverage represents barely 9%, with a number of 11 species, which provide barely 30 kg/ha GFY and 0.37 PV, being appreciated as a pioneer association without forage value. Particular importance was given to evaluating the production of GFY for assessed grassland associations, separately for each analyzed sandbank, in order to know the optimal animal load during the grazing season (Table 2).

In each sandbank and the associated micro-depressions, 1-4 distinct plant associations with different areas each were recorded. To evaluate the average productivity of the vegetation on each sandbank, it is necessary to map the area of each association and calculate the weighted average. Thus, the table above presents the arithmetic mean of the data from these plant associations as if they were present in equal proportions on each location. The highest vegetation coverage of 87-88% was recorded on the Stipoc and Chilia sandbanks, and the lowest of 53% on the Ciotic sandbank. The highest GFY production of 8.35 t/ha was evaluated at the Caraorman sandbank, which allows an optimal loading of 1 LU/ha and PV of 42, allowing 3300 l/ha of cow's milk to be obtained. The highest milk production, of 3930 l/ha, was evaluated on the Chilia sandbank where there are associations with *Agrostis stolonifera* and *Puccinellia distans*. These associations have a production potential of 5.69 t/ha GFY and a PV index of 50.4, which expresses the best forage quality of all the associations identified. The lowest milk production, of 1530 l/ha, was evaluated on the Ciotic sandbank, related to associations of sandy soils and micro depressions, with 3.32 t/ha GFY and a PV index of 19.7. On average, on the 7 sandbanks and micro-depressions, a productivity of 4.8-5 t/ha GFY was evaluated with a capacity of 0.57-0.60 LU/ha and a PV index of 33-34. With these productivity data, 2570-2660 liters of milk per hectare can be obtained in 130 days of optimal grazing season, considering also the prolonged drought period during the summer. The analysis of grassland productivity carried out by Maruşca et al. (2024) using the information provided by Popescu et al. (1997) compared with the data of Vasiu et al. (1963) evaluated in this paper indicates a degradation of production, forage quality and implicitly of the biodiversity of these grasslands. Thus, if in the 1960s the average production of GFY was about 4.9 t/ha and a PV index of 34,

in the 1990s the grasslands from the phytosociological alliances *Festucion vaginatae* and *Puccinelion limosae* recorded 2.9 t/ha GFY (59% of the initial value) and 22 PV index (65% of the value in the 1960s).

Table 2

Productivity of grasslands on the main sandbanks and micro-depressions in the Danube Delta in 130 days of grazing season (1958-1960)

Specification		Sandbank and micro-depression							Average
		Caraorman	Letea	Sărăturile	Stipoc	Perișoru	Chilia	Ciotic	
Plant association		A_1,A_3	A_1,A_2, A_3,A_5, A_6	A_2,A_5,A_6	A_3,A_5, A_6	A_2A_4, A_5	A_3,A_5	A_2	
Nr. of relevees		5	15	11	7	20	4	4	66
Avg. species no		24	16	20	11	30	8	27	19
Vegetation coverage (%)		72	64	70	87	63	88	53	71
Forage plants participation (%)		61	49	48	64	40	68	33	52
Harmful plant participation (%)		11	15	22	23	23	20	20	19
Green Fodde (GFY t/ha)		8.35	4.73	2.69	4.72	4.33	5.69	3.32	4.83
Animal load	(LU/ ha)	0.99	0.56	0.32	0.56	0.51	0.67	0.39	0.57
	%	173	98	56	98	90	118	69	100
Pastoral Value (ind. PV)		42.32	32.08	26.63	40.07	27.47	50.39	19.68	34.09
Milk production	(l/ha)	3300	2500	2080	3120	2140	3930	1530	2660
	%	124	94	78	117	80	148	58	100

These substantial decreases in GFY and PV index in the 1990s compared to the 1960s are mainly due to overgrazing with large animal herds, a widespread approach during the period of centralized socialist agriculture (Decree 92 of 1983). The aforementioned document required that the agricultural area in the delta was to increase from 66,185 ha in 1983 to 144,000 ha by 1990, of which 50,365 ha were permanent grassland. Thus, this grasslands on the sands were to be improved and provide partial food for 200,000 sheep and 20,000 cattle – an enormous additional pressure on extremely sensitive habitats.

CONCLUSIONS

The evaluation of the productivity of grasslands on the sandbanks and in the micro-depressions of the Danube Delta using information collected over 60 years ago and their comparative analysis with assessments based on more recent data shows a sharp degradation of the quality of the vegetation cover.

The calculation of productivity indicators, namely pastoral value and green fodder and milk production based on the floristic survey method unequivocally supports the statement regarding this decrease in the quality of the vegetation cover.

This degradation can be explained by the overexploitation of these areas in the period before the 1990s and by the abandonment of scientific methods and chaotic grazing that followed this period.

Comparative analysis of historical data can be a particularly useful tool for the rapid assessment and efficient management of changes that may occur in the structure of the vegetation cover, allowing the implementation of adequate conservation or restoration measures.

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