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Abstract. Wet meadows constitute valuable habitats for the wild flora and fauna and important resource for extensive animal husbandry, despite their limited extent. The objective of this research was to study the plant cover, floristic diversity and similarity of wet meadows under the effect of grazing. The study area was located in Axios Delta, northern Greece which has been grazed by free-ranging cattle throughout the year. Five subareas were selected in a distance of 500 and 1400 m away from the cattle shed (indicating differences in grazing intensity) namely; 'riparian-1400m', 'central-500m', 'central-1400m', 'channel-500m', 'channel-1400m'. The riparian area received higher amount of freshwater compared to the channel and central areas. Measurements of cover and vegetation composition were performed in eight plots in each of the subareas. Differences between the five subareas were tested by means of one way ANOVA and LSD test. The subarea riparian-1400m presented the highest rates of plant cover and floristic diversity, mainly due to the high soil moisture and low grazing intensity. Plant cover tended to be increased away from the shed, probably because of the decrease of grazing intensity. The similarity index was higher in the drier central subareas with higher soil salt content owing to the halophytes dominance in them.

Keywords. Wet grasslands – *Tamarix* species – Halophytes – Cows – Riparian areas.

Couverture végétale, diversité floristique et similarité de prairies humides pâturées par des bovins en liberté dans le delta d'Axios, Grèce

Résumé. *Les prairies humides constituent des habitats précieux pour la flore et la faune sauvage ainsi qu'une ressource importante pour l'élevage extensif, en dépit de leur faible étendue. L'objectif de cette recherche était d'étudier la couverture végétale, la diversité floristique et la similarité des prairies humides sous l'effet du pâturage. La zone d'étude, située dans le delta d'Axios au nord de la Grèce, a été pâturée en liberté tout au long de l'année. Cinq sous-zones ont été sélectionnées à une distance de 500 et 1400 mètres de l'étable (indiquant une intensité de pâturage différente), appelées : « riveraine-1400m », « centrale-500m », « centrale-1400m », « canal-500m », « canal-1400m ». La zone riveraine a reçu la plus grande quantité d'eau douce par rapport aux zones canal et centrale. Les mesures de recouvrement et de composition de la végétation ont été réalisées en huit emplacements dans chacune des sous-zones. Les différences entre les cinq sous-zones ont été testées au moyen d'une analyse de variance ANOVA et du test de LSD. La sous-zone riveraine-1.400m a présenté les taux de couverture végétale et de diversité floristique les plus élevés, principalement en raison de la forte humidité du sol et la faible intensité du pâturage. La couverture végétale a eu tendance à augmenter avec l'éloignement de l'étable, probablement en raison de la diminution de l'intensité de pâturage. L'indice de similarité était plus élevé dans les sous-zones centrales sèches avec une teneur plus élevée en sel dans le sol en raison de la domination des halophytes dans ces zones.*

Mots-clés. *Prairies humides – Espèces de* Tamarix *– Halophytes – Vaches – Zones riveraines.*

I – Introduction

Wet meadows are covered by characteristic plant communities composed of species adapted to periodically flooded soils, either along the river flood zones or in lakeside zones. Despite their limited extent, they constitute valuable habitats for the wild flora and fauna and important resource for extensive animal husbandry. The grazing of free-ranging cattle is a traditional management practice suitable for wet meadows for several reasons such as the constant supply of freshwater, the high forage productivity even during the dry summer periods and flat terrains. These characteristics constitute wet meadows as ideal grazing lands for cattle. (Tsougrakis, 1995). Overgrazing is mentioned as a potential threat for the majority of Greek wetlands sites, indicating the need of constant monitoring of their conservation status (Papaporfyriou *et al*., 2014). The monitoring of the effect of grazing on wetlands could be achieved by a variety of measurements such as plant cover, floristic diversity and similarity indices (Tsougrakis, 1995; Buttolph and Coppock, 2004).

The objective of this research was to study the effect of grazing by free-ranging cattle on wet meadows by the use of the three above-mentioned parameters.

II – Materials and methods

The study area is located in Axios Delta, northern Greece and its altitude varies from -1m up to +2m a.s.l. The climate of the area is classified as semiarid with a mean annual air temperature of 14.7°C and a mean annual precipitation of 427.9 mm. It is covered by three vegetation (habitat) types of European Community interest (Council Directive 92/43/EEC): i) '1420 – Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*)', ii) '1310 – *Salicornia* and other annuals colonising mud and sand' and iii) '92D0 – Southern riparian galleries and thickets (*Nerio-Tamaricetea* and *Securinegion tinctoriae*)'. The area is protected by Ramsar Convention of Wetlands (signed in Iran, 1971) thanks to its unique avifauna interest. The study area belongs to the National Park of Axios-Loudias-Aliakmonas Delta which was legislated by Joint Ministerial Decision in Greece in 2009. The study area has been grazed since 1930s when Axios Delta was created after the diversion of Axios River. Nowadays, this area is grazed by 200 free-ranging cattle all over the year.

Six subareas were selected in a distance of 500 and 1400 m away from the cattle shed namely; 'riparian-500m', 'riparian-1400m', 'central-500m', 'central-1400m', 'channel-500m', 'channel-1400m'. During the period of field data collection, it was impossible to obtain measurements in the subarea riparian-500m because that area was fenced. The riparian area (1400m) received higher amount of freshwater compared to the channel and the central areas. Measurements of cover and vegetation composition were performed in each of the subareas during June in 2015. Plant cover was recorded along each transect using the line-point method (Cook and Stubbendieck, 1986). Eight transects of 25 meters long were placed vertically along a measure tape of 50m every six meters, starting from 0m to 42m., The species abundance, the diversity indices of Shannon-Wiener, evenness, Berger-Parker and Simpson (Magurran, 1988) were estimated for each transect.

All data were analyzed statistically by using one way ANOVA in SPSS ver.20 (IBM Corp. Released 2011) concerning the plant cover and floristic diversity and PAST ver.3.0 (Hammer *et al*., 2001) concerning the Morisita similarity index (Morisita, 1959). The LSD test was applied to detect the differences among means at 0.05 level of significance (Steel and Torrie, 1980).

III – Results and discussion

Plant cover was found significantly higher only in the riparian-1400m subarea (Table 1). This finding may be attributed to the beneficial effect of freshwater and the high distance from the

shed. In addition, plant cover tended to be higher, although not significantly, in all the distant from the shed subareas.

The floristic diversity indices (Table 1) presented their highest values in the riparian-1400m. More specifically, species abundance was found significantly higher in the riparian-1400m subarea compared to the central-500m and channel-1400m subareas, probably for the same reasons that cover was significantly higher in this subarea. Likewise, the Shannon-Wiener diversity and Berger-Parker index were found also significantly higher in the riparian-1400m in comparison with the central-500m and channel-1400m subareas. No significant differences were detected for the evenness index between the subareas. Simpson index was found increased in the riparian-1400m subarea, but this trend was statistically significant only in comparison to the channel-1400m subarea, probably because the latter was dominated by a small number of species.

Table 1. Mean values of plant cover, number of taxa and the diversity indices of Shannon-Wiener, evenness, Berger-Parker and Simpson in the studied subareas

Subareas	Plant Cover	Taxa (S)	Shannon - Wiener (H)	Evenness	Berger - Parker	Simpson 1/D
Central-500m	78.13b	8.06bc	1.40b	0.62a	0.54a	3.65a
Channel-500m	69.13b	9.25ab	1.75ab	0.65a	0.40b	4.08a
Riparian-1400m	92.44a	11.56a	1.92a	0.62a	0.35b	4.82a
Central-1400m	79.63b	9.00abc	1.64ab	0.60a	0.46b	3.72ab
Channel-1400m	79.38b	5.88c	0.92c	0.64a	0.70a	2.17b

Different letters in the same column indicate significant differences among the five subareas ($p \leq 0.05$).

Morisita similarity index (Table 2), indicated high similarity (0,89) between the central subareas (central-500m and central-1400m). This could be attributed to the fact that these subareas represent the most extreme environments in the terms of soil dryness and salt content and for this reason are dominated by few stress-tolerant species. Furthermore, maybe the higher intensity of grazing in these subareas favors a homogenization of floristic composition. The central-500m subarea has been overgrazed for several years, especially during the early phenological stage of grasses and forbs which led to the dominance of halophytes. The central-1400m subarea is also dominated by halophytes but in this case, this may be attributed mostly to the higher salt content of soil. High similarity (0.83) was also found between the central-500m and channel-1400m subareas, possibly due to the presence of halophytes in the latter subarea, despite the dominance of *Tamarix* sp. shrubs.

Table 2. Values of Morisita similarity index between the studied subareas

Subareas	Central-500m	Channel-500m	Riparian-1400m	Central-1400m	Channel-1400m
Central-500m	1.00				
Channel-500m	0.33	1.00			
Riparian-1400m	0.28	0.54	1.00		
Central-1400m	0.89	0.18	0.21	1.00	
Channel-1400m	0.83	0.31	0.39	0.69	1.00

IV – Conclusions

Plant cover and diversity indices presented the highest values in the subarea riparian-1400m, mainly due to the high soil moisture and low grazing intensity. Plant cover tended to be increased away from the shed, probably owing to the decrease of grazing intensity. The similarity index was higher between the most extreme (dry soils and with high salt content) or highly grazed habitats because both factors have led to the dominance of few halophytes.

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