COMMUNITIES WITH EURPHORBIA MACULATA IN THE NORTH CAUCASUS AND THEIR SYNTAXONIC CLASSIFICATION IN EASTERN EUROPE

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Abstract

The article studies the distribution of the alien species Euphorbia maculata L. in the North Caucasus. The species was first recorded in the region in 2006 and is now widely distributed. This study presents the species relationship to habitats and the floristic composition of plant communities. Communities were compared with similar ones in Europe and a new weed association Euphorbio maculata-Acalyphetum australis ass. nova was analysed. Diagnostic species: Euphorbia maculata, Acalypha australis. Summer-dry trampled vegetation with Euphorbia maculata in crevices of sealed asphalt and tile coating of sandy subsoil (on sandy soils), on gravel ground of tram and railway tracks of the Nortn Caucasus region. The Euphorbia maculata communities are often found in cracks of pavement, laid on sand substrate, asphalt cracks of suburban areas and along highways.

Keywords: biological diversity, digitario sanguinalis-eragrostietea minoris mucina, plant communities, invasion, Euphorbia maculate, Acalypha australis, syntaxonomy, North Caucasus, slit biotype, anthropogenic ecosystems

I. Introduction

Euphorbia maculata is an invasive species that is widely distributed throughout the world. Its natural range covers eastern and southern parts of North America [1], where it is classified as weedy species [2]. Its typical habitat is sand on the seashore, mounds along roads [3]. It has been naturalized in Central and South America, the Middle East, East Asia, New Zealand and Australia. In Europe, *Euphorbia maculata* appeared several centuries ago. In the last two decades, the species has significantly expanded its range [3-6]. In the North Caucasus, the species was first recorded in 2006 [7]. It is found in an environment with sharp temperature fluctuations during the day, different from the general habitat of plants and prefers to grow in open sunny places, digs the tile, crevice and gravel biopaths of railways and highways. *Euphorbia maculata* is a bitter weed of agrocenoses. It inhibits the growth of wheat seeds [8, 9], reduces soybean yields [10], cotton [11], tomatoes (*Lycopersicon esculentum*) and chilli pepper (*Capsicum annuum*) [12].

Climate change promotes the spread of alien species adapted to xerophytization. This is particularly relevant for the Krasnodar Region where a big area is occupied by agrocenoses, which are favorable locations for further invasion of *Euphorbia maculata*. The study of plant communities with *Euphorbia maculata* in the North Caucasus in the context of the European syntaxon of vegetation will help to better understand the patterns of formation of urban flora and develop strategies for management of invasive species. The integration of studied plant communities with *Euphorbia maculata* in the North Caucasus into the European Vegetation Syntaxon will allow a better understanding of the patterns of formation of flora of anthropogenic ecosystems and develop strategies for management of invasive species.

II. Methods

The work is based on 70 relevés, carried out by the author in 2021-2023 in the territory of Krasnodar Region (city of Krasnodar, Novorossiysk, Dzhubga, Big Sochi) of the republic of Abkhazia (city of Pitsunda) (Figure 1).

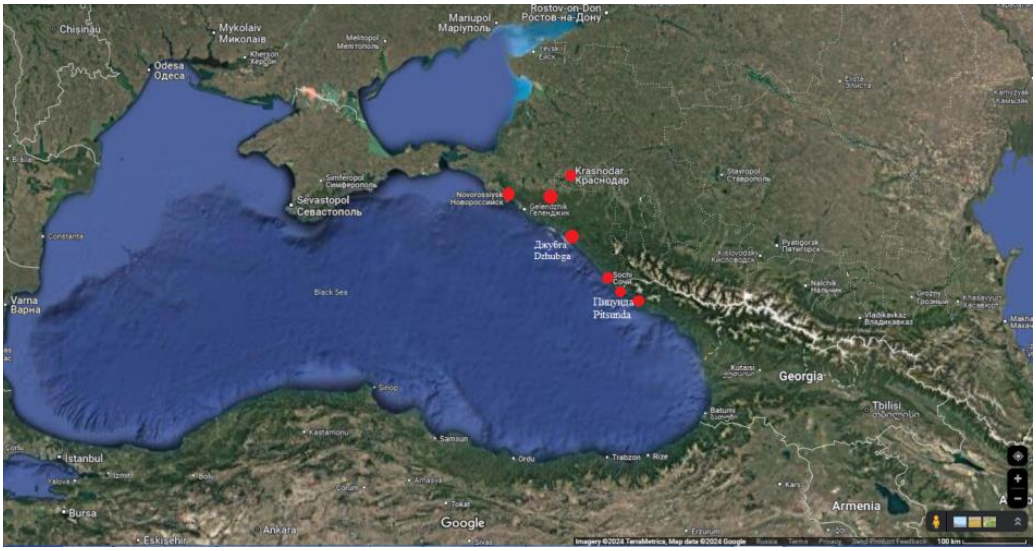

Figure 1: *Distribution of Euphorbia maculate in the North Caucasus*

The cracks between the pavement tiles, which are placed on sand substrate (figure), cracks of railway stations, suburban and residential areas (figure), sidewalks along roads (figure), bridges, city parks were investigated. 23 relevés were selected for the characteristics of the plant species that were studied. The sample area is ranged from 6 to 100 m^2.

In the relevé of the floral composition, the abundance of species was assessed by the Brown-Blank scale: r - single species, mostly only one specimen; + - species are thinned or cover only a small part of the area; 1 - species are numerous but cover up to 5 % or quite thinned, but with a higher coverage; 2 - projective coverage up to 5-25% or individuals are very numerous, but coverage is lower; 3 - projective coverage up to 26-50%; 4 - projective coverage up to 51-75%; 5 - projective coverage more than 75%. The relevés were processed by Brown-Blank [10], using MEGATAB [14] and TWINSPAN [15] software packages. The names of the highest syntaxa are given in «Vegetation of Europe...» [16]. The names of new syntaxa are given in accordance with the rules of the «International Code of Phytocenolological Nomenclature» [17]. Species names are updated according to the summary of S. K. Cherepanova [18].

III. Results

Syntaxa with Euphorbis maculate were first identified in North Korea as ***Polygono-Poetea annuae*** in 1991 [19], which was later reviewed by Vegetation of trampled soil dominated by C 4 plants in Europe – class ***Stellarietea*** [20], in Prodromus of Europe [16] and entered into a new class of anthropogenic vegetation ***Digitario sanguinalis-Eragrostietea minoris*** Mucina, Losová et Šilc in Mucina & al. 2016. Comparison of selected plant phytocoenons of communities with *Euphorbia maculata* with literature data [20] revealed differences in taxa lists (table 1). This made it possible to include them in a new association.

Table 1: *Synoptic table of plant communities dominated by Euphorbia maculate*

Class	Column number	1	2	3	4	5	6	7	8	9
	Number of relevés	26	1	6	14	5	19	12	1	39
DIG	Euphorbia maculata	100	2	11	11	11	21	43	56	11
Class ***Digitario sanguinalis-Eragrostietea*** minoris Mucina, Lososová et Šilc in Mucina & al. 2016										
DIG	*Portulaca oleracea*	78	21	21	21	21	21	31	21	11
DIG	*Digitaria sanguinalis*	74			21	11	11	21	53	42
DIG	*Eleusine indica*	65			11	11	55	11		
DIG	*Setaria viridis*	52			21	31	11	42	31	21
DIG	*Taraxacum officinale*	39			21	11	21	41	54	21
DIG	*Eragrostis minor*	22			21	21	42	53	21	56
DIG	*Setaria pumila*	13								11
DIG	*Sorghum halepense*	9								
DIG	*Tragus racemosus*	9					11	11		11
DIG	*Senecio vernalis*	4			11					11
DIG	*Tribulus terrestris*	4			11					11
DIG	*Amaranthus blitoides*	4								
	Acalypha australis	57								
	Gleditsia triacanthos	9								
	Cyclospermum leptophyllum	9								
	Coronopus didymus	4		21	11					11
	Platanus occidentalis	4								
	Amaranthus deflexus	0	+	21	21	56	21	11	31	
DIG, BID	*Echinochloa crus-galli*	0							11	11
DIG, POL	*Polygonum aviculare*	70	1	21	42	42	56	42	57	54
DIG, POL	*Cynodon dactylon*	9	+	11	21	11	21	11	31	31
Class ***Sisymbrietea***										
SIS	*Conyza canadensis*	61	+	11	11	11	11	21	11	11
SIS	*Ambrosia artemisiifolia*	17								
SIS	*Chenopodium album*	13		11	11	11			11	31
SIS	*Amaranthus retroflexus*	4			11	11			11	11
SIS	*Lactuca saligna*	4								
SIS	*Crepis foetida*	4								
SIS	*Malva neglecta Wallr.*	0					11			
SIS	*Lactuca serriola*	0		11						11
SIS	*Atriplex tatarica*	0							11	11
SIS, PAR	*Convolvulus arvensis*	22		11	11	11		21		11
SIS, PAR	*Stellaria media*	4			11		11			11
SIS, SED	*Erodium cicutarium*	0								11
Class ***Artemisietea vulgaris***										
ART	*Plantago lanceolata*	13					11	31		
ART, BUL, FES	*Medicago lupulina*	9			11		11		11	21
ART, EPI	*Erigeron annuus*	4								
ART	*Verbascum blattaria*	4								
ART	*Picris hieracioides*	4								
ART	*Melilotus officinalis*	4								

ART	*Artemisia absinthium L.*	0			21	11	11		11
ART	*Artemisia vulgaris*	0			11	11	11		11
ART	*Artemisia vulgaris L.*	0				11	31		11
ART, MOL	*Daucus carota*	0						11	11
ART, SIS	*Crepis setosa*	26							
Class ***Papaveretea rhoeadis***									
PAR	*Oxalis corniculata*	30	31	54	11	11			
PAR	*Galinsoga quadriradiata*	4		11		11			
PAR	*Veronica polita*	4							
PAR	*Alopecurus myosuroides*	4							
PAR, SIS	*Sonchus oleraceus*	26	21	11	42	11	11		11
PAR, SIS	*Capsella bursa-pastoris*	0	11	11	11			31	11
PAR, SIS	*Solanum nigrum*	0		11					11
PAR, SIS	*Sonchus asper*	0							11
Class ***Polygono-Poetea annuae***									
POL	Poa annua	48	53	21	31	21	31	31	11
POL, MOL	Plantago major	35	11	21	11	11	53	42	32
MOL	Lolium perenne	13		11	21	11		21	11
MOL	Paspalum dilatatum	9							
MOL	Potentilla reptans	4							
MOL	Juncus tenuis	4							
POL	Sagina procumbens	4		11		21	11	21	11
POL	Cotula australis	0	11						
POL	Sclerochloa dura (L.) Beauv.	0		11	11				
POL	Spergularia rubra	0	21					11	11
POL	Plantago coronopus	0	42	11		11	11		
POL	Herniaria glabra	0		11		11	21		
POL	Lepidium ruderale	0							11
MOL	Trifolium repens	0	11	11	11	11	21	31	21
MOL	Verbena officinalis	0		11		21	31		
Other species									
CHE	*Hordeum leporinum*	17		11	11	11		11	
CHE	*Parietaria judaica L.*	0		21	31	11			
EPI	*Calystegia sepium*	4							
EPI, CYM, ROB	*Chelidonium majus*	4							
EPI, POP	*Humulus lupulus*	4							
FEP	*Galium humifusum*	4							
FES	*Crepis pannonica*	4							
ROB	*Ailanthus altissima*	9							
SED	*Petrorhagia saxifraga*	0		11		11	43		
SED, TRA	*Arenaria serpyllifolia*	9				11	11	21	11
SED, TRA, TUB	*Medicago minima*	9							

1 ***Euphorbio maculata-Acalyphetum australis***, Russia (this paper), 2 Eup***horbietum chamaesyco-prostratae*** Rivas-Martínez, Madrid, ES, 3 ***Gnaphalio luteo-albi-Polycarpetum tetraphylli*** Ortiz & Rodríguez-Oubiña (1990: Tab. 2) C & N Portugal, 4 ***Euphorbio chamasyce-Oxalidetum corniculatae*** Lorenzoni 1964, 5 ***Polycarpo tetraphylli-Amaranthetum deflexi*** Pignatti 1953, Italy (Poldini, 1989), Croatia (Čarni, 1995), 6 ***Eleusinetum indicae*** Pignatti 1953, 7 ***Euphorbietum maculatae*** Poldini 1989, 8 ***Polygono avicularis-Euphorbietum maculatae*** (Tímár, 1950) Čarni & Mucina (1998), Hungary (Tímár, 1950), (Čarni, Mucina, 1998), 9 ***Eragrostio-Polygonetum avicularis*** Oberd. 1954, 10 ***Portulaco-Euphorbietum maculatae*** (Brandes 1993) Čarni & Mucina (1998)

The position of the characterized communities with Euphorbia maculate in the system of higher syntaxa is presented as follows:

Class ***Digitario sanguinalis-Eragrostietea minoris*** Mucina, Lososová et Šilc in Mucina et al. 2016

Order ***Eragrostietalia*** J. Tx. ex Poli 1966

Alliance ***Polycarpo-Eleusinion indicae*** Čarni et Mucina 1998

Acc. ***Euphorbio maculata-Acalyphetum australis*** ass. nova hoc loco

IV. Discussion

Digitario sanguinalis-Eragrostietea minoris is a new class of anthropogenic vegetation uniting therophyte communities of annual plants in southern non-moral, Mediterranean, steppe and semi-desert zones of Europe (Mucina et al., 2016). Diagnostic types of class: *Amaranthus albus, Anisantha sterilis, A. tectorum, Bromus squarrosus, Conyza canadensis, Corispermum hyssopifolium, Digitaria ischaemum, D. sanguinalis, Echinochloa crusgalli, Eragrostis minor, Eragrostis pilosa agg., Lepidium densiflorum, Panicum miliaceum, Plantago arenaria, Polygonum aviculare agg., Portulaca oleracea, Salsola australis, Senecio vernalis, S. viscosus, Setaria pumila, S. pycnocoma, S. verticillata, S. viridis, S. weinmannii.*

In the Krasnodar Region, the class is represented by the order ***Eragrostietalia*** - communities of juveniles on dry and warm sandy or other drained soils.

Diagnostic types of order = Diagnostic types of class.

According to the latest survey of vegetation in Europe (Mucina et al., 2016) this order has a complex structure of alliances which are divided into 3 groups, combining the segmental vegetation of the temperate zone, segmental vegetation of the Mediterranean and the ruderal vegetation. The investigated phytocoenoses are classified to the Alliance ***Polycarpo-Eleusinion indicae*** Čarni et Mucina 1998.

Ass. ***Euphorbio maculata-Acalyphetum australis*** ass. nova hoc loco (table. 1) Diagnostic species: *Euphorbia maculata, Acalypha australis*.

Type of nomenclature (holotypus hoc loco) - op. 9 in table. 1: *Euphorbia maculata* - 1, *Portulaca oleracea* - +, *Digitaria sanguinalis* - 1, *Polygonum aviculare* - 2, *Eleusine indica* - +, *Setaria pumila* - +, *Acalypha australis* - +, *Conyza canadensis* - +, *Sonchus oleraceus* - +, *Chenopod*ium album - +, *Lactuca saligna* - +, *Crepis setosa* - +, *Plantago major*- +. Krasnodar Region, the city of Krasnodar. 15.07.2023.

Summer-dry trampled vegetation with *Euphorbia maculata* in crevices of sealed asphalt and tile coating of sandy subsoil (on sandy soils), on gravel ground of tram and railway tracks of the North Caucasus region.

This marginal community is often found in the cracks of pavement tiles, laid out on sand substrate (figure), asphalt cracks of adjacent and near the fence areas (figure), sidewalks along roads (figure), bridges, railway platforms, parks. The basis of the grass stand consists of *Euphorbia maculate, Digitaria sanguinalis, Polygonum aviculare, Setaria viridis, Portulaca oleracea* (with abundance 3-15%, on average 7%). The grass stand is thinned unevenly, the total projective coverage is 5-35%. Its height depends on the intensity of poaching and varies from 5 to 40 (60) cm. The average height is 17 cm. The floristic richness of communities is low (10-16 species).

In the associations, the main phytocenotical positions are occupied by the alien plant species *Euphorbia maculate, Digitaria sanguinalis, Acalypha australi, Setaria pumila, Eleusine indica, Ambrosia artemisiifolia, Amaranthus retroflexus, Conyza canadensis, Sorghum halepense, Setaria pumila, Paspalum dilatatum, Juncus tenuis*.

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