

Weed communities of root crops in the Pamir Alai Mts, Tajikistan (Middle Asia)

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Abstract

The paper presents the results of investigations of weed vegetation conducted on root crops in Tajikistan (Middle Asia), one of the world cradles of weed flora. The main research was conducted in the Zeravshanian, southern Tajikistan and Hissar-Darvasian geobotanical regions in 2011. The study was based on 107 phytosociological relevés obtained in various geobotanical regions of the country. The collected material probably presents the majority of variations among the weed communities of root cultivations in the Middle Asia. As a result of numerical analyses, 7 associations were distinguished: *Convolvulo arvensis-Cyperetum rotundi*, *Daturo stramonii-Hibiscetum trioni*, *Setario pumilae-Sorghetum halepensi*, *Galinsogo-Setarietum*, *Equiseto arvensi-Xanthietum italici*, *Portulacetum oleracei* and *Brassico campestris-Lamietum amplexicauli*. The last mentioned is new to science. Additionally, one subassociation has been proposed (*Convolvulo arvensis-Cyperetum rotundi kochietosum scopariae*). The main discrimination factor for the data set is the floristic structure of the associations. The study shows that root-crop plantations with segetal vegetation may harbor a relatively rich flora. Almost 200 species were found in vegetation plots, including some, which are rare and have not been recorded until now in this part of Middle Asia. However, most of the recorded species are widespread weeds typical for the Mediterranean and Irano-Turanian geobotanical provinces.

Keywords: *Stellarietea mediae*, *Atriplici-Chenopodietalia*, agrocoenoses, segetal communities, Tadzshikistan

Introduction

According to the ten-volume flora of the former Soviet Socialist Republic of Tajikistan [1–8], supplemented by the works of Zakirov [9], Tzvelev [10], and Ikonnikov [11], ca. 4550 vascular plant species occur in Tajikistan. This number is not final, as recently some new records regarding the Tajik flora have been published (e.g. [12–17]). Moreover, some species new to science have been described based on plant specimens collected in the general area of this country (e.g. [18–25]). Tajik vascular plant flora is considered as among the richest in the area of the former Soviet Union. This area is also recognized as one of the most important centers of weed species in the world [26]. Approximately 30% of vascular plant species known from Tajikistan are generally accepted endemics of the country [8,27,28]. It is worth mentioning that the Pamir-Alai range is part of the middle Asian mountain system recognized by Conservation International to be among thirty-four so-called

hotspots of biodiversity [29] and as one of the eleven most important focal points of future plant diversity studies and conservation [30]. On the other hand, having the near-lowest adaptive capacity to climate instability, Tajikistan is regarded as the country most sensitive in the world to climate change [31]. According to Baettig et al. [32], it is exposed to a high risk of climate change, which is going to be one of the most important degradation factors for the vegetation cover of the country.

Recent syntaxonomical studies of segetal communities have been carried out for several years now in many regions of the world, mainly in countries of Central Europe (e.g. [33–39]) and Asia [40–42]. For several regions similar in terms of climatic conditions (the Mediterranean and Irano-Turanian geobotanical provinces) useful data regarding field communities are available, e.g. for Afghanistan, Serbia, Italy, Greece, Romania, Bulgaria, and Spain [43–50]. There is little data from the Saharo-Sindian province, where numerous weed species ranging as far as Tajikistan in the east originate [51–53]. Unfortunately, to date, in some regions of Central Asia, for example in Kyrgyzstan, Kazakhstan, or Uzbekistan, no research on the plant communities of these field ecosystems has been conducted. This applies to cereal as well as root crops.

Research on agrocoenoses has been carried out across the globe, within a range of contexts and with different levels of intensiveness. Recently, a large number of papers have documented the problem of maintaining conservation values for agrocoenoses in relation to the intensification of crop production. In Europe as well as in Asia, for cereal and root crops, a decrease in biodiversity has been noted, as exemplified by the

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abandonment of unprofitable crops (especially in middle and higher mountain elevations) and intensification of the production of others [54–60].

In some regions of the world, relationships between the richness of vegetation patches and various abiotic factors, as well as the abundance of weed flora in crop communities, e.g. altitude, soil type, climate, etc., have been relatively well studied [61–65].

A number of studies have appeared recently, which record basic floristic and vegetation data for root crops or cereals, often focusing on their special role for the protection of threatened or endemic species [66–70]. As well, vanishing and rare species, and communities related to agricultural land and weed habitats other than agrocoenoses, have been a center of attention for botanists in recent years [58,71–76]. Additionally, changes in segetal flora over the years have been analyzed (e.g. [77]). The growing interest in endangered weed species is the reason for the first conservation projects involving extinct or disappearing taxa (e.g. [78]). Specific biological features, which are probably responsible for weed regression (e.g. [79]) or expansion (e.g. [80]) have received less attention. Therefore, it is nearly incomprehensible that within one of the world's cradles of weeds, virtually no conservation research focused on weed flora has been conducted.

Phytosociological research is essential in order to document the syntaxonomic diversity of weed phytocoenoses. Unfortunately, only a few works focused on vegetation classification have been issued recently [81–83]. They are all the more important because so far there have been no syntaxonomic works on segetal communities published on this country, even though the vegetation is so rich and relatively well preserved due to the low intensity of cultivation. Outside Middle Asia, segetal weed vegetation studies have been conducted for a few areas situated a bit further within the region, e.g. Bashkortostan (southern Urals) and Mongolia in Central Asia [41,42,84].

Material and methods

Study area

Tajikistan covers 143500 km² and is situated in the Middle Asia between E 36°40'–41°05' and N 67°31'–75°14' (Fig. 1). This is a typically mountainous country, with more than 50% of the area located above 3000 m. The southern part of Tajikistan is influenced by a subtropical climate, while the northern part is situated in the temperate climate zone [85]. Generally, the country is characterized by high insolation, a low percentage of cloud cover, high amplitude of annual temperatures, low humidity and low precipitation. In subtropical regions of Tajikistan, the average temperatures in June are around 30°C. In the temperate zone, which in Tajikistan comprises mainly the high mountains, the climate is much harsher, with average temperatures in July between 9.7°C and 13.5°C. Annual precipitation in Tajikistan ranges from ca. 70 mm (in the Pamirs) to ca. 600 mm (in the Hissar Range). The lower limit of perpetual snow is at an altitude of 3500–3600 meters above sea level in the western part of the country, 5800 m in the eastern regions (Fig. 2) [86,87]. The cultivation zones are distributed in accordance with the perpetual snow cover, from ca. 350–3300 m in western Tajikistan up to about 4800 m in eastern Pamir.

This study was conducted in the northern, northwestern, southwestern and southeastern parts of Tajikistan, mainly in the valleys of the Syr Darya, Amu Darya, Pyandzh, Veshan,

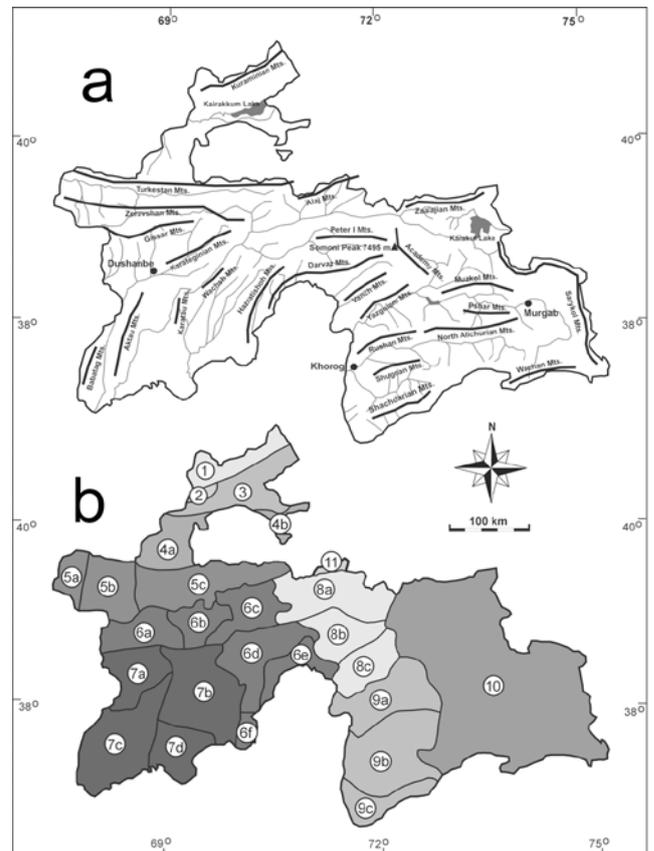


Fig. 1 a The area of Tajikistan with main cities, mountain ridges, rivers and lakes. b The geobotanical division of Tajikistan: 1 – Kuraminian; 2 – Mogoltauasian; 3 – Prisyrdarian; 4a – Turkestanian A; 4b – Turkestanian B; 5a – Zeravshanian A; 5b – Zeravshanian B; 5c – Zeravshanian C; 6a – Hissar-Darvasian A; 6b – Hissar-Darvasian B; 6c – Hissar-Darvasian C; 6d – Hissar-Darvasian D; 6e – Hissar-Darvasian E; 6f – Hissar-Darvasian F; 7a – South Tajikistanian A; 7b – South Tajikistanian B; 7c – South Tajikistanian C; 7d – South Tajikistanian D; 8a – East Tajikistanian A; 8b – East Tajikistanian B; 8c – East Tajikistanian C; 9a – West Pamirian A; 9b – West Pamirian B; 9c – West Pamirian C; 10 – East Pamirian; 11 – Alajian.

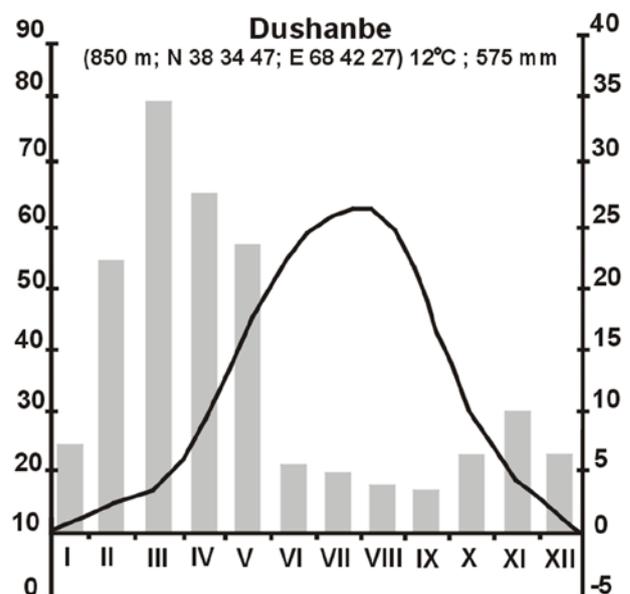


Fig. 2 Climatic characterisation of the study area according to the Dushanbe weather station.

Vakhsh, Zeravshan, Kafirnighan, Khanaka and Surkhan Darya Rivers, where vast areas of root cultivations are concentrated. The studied vegetation patches are located between 344 and 2615 meters above sea level. They are developed on different types of substrate, with a range of soil pH between 6.8 to 7.9, and containing various granulometric structures.

Data and analyses

The field study was conducted in 2011. During the study 107 phytosociological relevés were made. The plot size used to sample vegetation was established so as to represent full floristic composition, varying from 25 to 30 m² depending on plant density and homogeneity of vegetation cover. For each vegetation patch all vascular plants were recorded. Cryptogams were not noted because of their secondary importance in the segetal communities in the Middle Asia. Plant species were recorded according to the Braun-Blanquet cover-abundance scale [88]. Geographical coordinates, elevation above sea level, aspect and slope inclination were noted for each relevé.

All relevés were stored in a database using the JUICE software [89]. A TWINSpan analysis [90] was used to perform the preliminary classification of communities. The data from the relevés showed a clear unimodal response, enabling us to use a detrended correspondence analysis (DCA) with a floristic data set (presence-absence data, no down weighting of rare species) to check floristic-sociological classification and to show relationships between the groups. For ordination, CANOCO for Windows 4.5 was used [91].

Vegetation classification follows the sorted table approach of Braun-Blanquet [88]. In the analytic tables (Tab. S1, Tab. S2, Tab. 1–Tab. 3), species constancies are given in classes I–V [92]. In cases where a particular species was noted in less than 8 relevés, the absolute number of species occurrences was specified. Newly presented syntaxa described as associations or subassociations were proposed according to the international code of phytosociological nomenclature [93]. In distinguishing a given association, the works of Sirbu [94], Brullo et al. [45], Matuszkiewicz [37], Šilc & Čarni [38], Sanda et al. [47], Chytrý [95], Tzonev et al. [50], Bagrikova [96], Ninot et al. [97] and Wittig et al. [53] were taken into account. The association concept follows Willner [98]. The presented communities are arranged into a syntaxonomic overview at the end of the “Results” section.

Species nomenclature mainly followed Czerepanov [99]. Plant material collected during field studies was deposited in the Herbarium of Middle Asian Mountains, hosted in OPUN (Opole University, Poland) and KRA (Jagiellonian University, Poland).

Results

The number of taxa recorded in the relevés totals 182, of which 59 exceed 5% constancy and 36 exceed 10%. The species with the highest frequencies include: *Convolvulus arvensis* (80 occurrences), *Chenopodium album* (68), *Cyperus rotundus* (62), *Portulaca oleracea* (47), *Xanthium italicum* (45), *Echinochloa crus-galli* (43), *Amaranthus retroflexus* (42), *Cynodon dactylon* (40), *Polygonum aviculare* (37), *Sonchus oleraceus* and *Sorghum halepense* (34), *Hibiscus trionum* (32), *Setaria viridis* (31), *Setaria pumila* and *Lamium amplexicaule* (25). Not all of the species noted in relevés are typical of root crop vegetation. In the studied phytocoenoses, species typical for cereal crop

Tab. 1 *Galinsogo-Setarietum*.

	1	2	3	4	5	6	7	Number of occurrence	
Successive number of relevé	1	2	3	4	5	6	7		
Day	2	17	2	2	2	2	2		
Month	6	6	6	6	6	6	6		
Year	2011	2011	2011	2011	2011	2011	2011		
Altitude (m)	1254	1021	1254	1180	1158	1254	1158		
Cover of herb layer (%)	50	40	20	35	40	40	35		
Relevé area (m²)	30	30	30	30	30	30	30		
pH	7.2	7.2	7	7	7	6.8	6.9		
Number of weeds	10	16	16	14	14	10	13		
Cultivated plants									
<i>Solanum tuberosum</i>	.	.	.	4	3	3	4		
<i>Allium porrum</i>	.	2	.	.	.	.	.
<i>Citrullus lanatus</i>	.	+	.	.	.	.	.
<i>Cucumis sativus</i>	3	.	.	.	.	.	.
<i>Daucus carota</i>	.	.	5	.	.	.	.
Diagnostic species									
Ass. <i>Galinsogo-Setarietum</i>									
<i>Galinsoga parviflora</i>	2	2	1	2	3	3	3	7	
<i>Galinsoga ciliata</i>	+	+	+	+	.	.	.	4	
All. <i>Oxalidion fontanae</i>									
<i>Oxalis fontana</i>	+	+	+	+	1	1	+	7	
<i>Sonchus oleraceus</i>	.	+	.	1	+	+	+	5	
<i>Veronica persica</i>	.	.	+	1	+	.	.	3	
O. <i>Atriplici-Chenopodietalia albi</i> & Cl. <i>Stellarietea mediae</i>									
<i>Kochia scoparia</i>	3	2	1	+	+	+	.	6	
<i>Polygonum aviculare</i>	.	+	.	1	+	+	+	5	
<i>Polygonum persicaria</i>	1	+	+	.	.	.	+	4	
<i>Setaria pumila</i>	+	+	+	1	.	.	.	4	
<i>Sisymbrium altissimum</i>	.	.	+	+	+	.	+	4	
<i>Chenopodium album</i>	.	1	1	+	.	.	.	3	
<i>Spinacia turkestanica</i>	+	.	.	.	+	.	.	2	
Sporadic species: <i>Amaranthus retroflexus</i> 2; <i>Bromus sterilis</i> 3; <i>Capsella bursa-pastoris</i> 3; <i>Cynodon dactylon</i> 2(1); <i>Cyperus rotundus</i> 2; <i>Fallopia convolvulus</i> 2; <i>Geranium pusillum</i> 3; <i>Portulaca oleracea</i> 2(1); <i>Setaria viridis</i> 2.									
Others									
<i>Trifolium repens</i>	.	.	+	1	1	1	+	5	
<i>Taraxacum</i> sp.	+	.	.	+	+	+	+	5	
<i>Plantago lanceolata</i>	.	+	+	.	+	+	+	5	
<i>Plantago major</i>	.	.	.	+	+	1	1	4	
<i>Poa annua</i>	+	.	.	+	+	.	.	3	
<i>Trifolium pratense</i>	.	.	1	.	.	.	+	2	
<i>Anethum graveolens</i>	+	.	.	.	+	.	.	2	
<i>Stellaria neglecta</i>	.	.	+	.	.	.	+	2	
<i>Isatis tinctoria</i>	.	.	.	.	.	+	+	2

Locality of relevé: 1 – (382728; 704625,5); 2 – (383810; 690840); 3 – (382728; 704625,5); 4 – (382728; 704625,5); 5 – (382728; 704625,5); 6 – (382728; 704625,5); 7 – (382728; 704625,5).

communities have also been observed: *Anthemis altissima*, *Anagallis foemina*, *Avena trichophylla*, *Fagopyrum tataricum*,

Tab. 2 *Brassica campestris-Lamietum amplexicauli* ass. nova.

Successive number of relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Constancy	
Day	6	4	14	14	5	7	7	13	10	13	13	13	14	15	15	15	8	8		
Month	6	6	6	6	6	6	6	6	5	6	6	6	6	6	6	9	9			
Year	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011		
Aspect	-	-	-	-	-	NE	-	-	-	-	-	-	-	N	N	-	-	-		
Inclination (degrees)	-	-	-	-	-	3	-	-	-	-	-	-	-	15	15	-	-	-		
Altitude (m)	1967	2182	2049	2050	2615	2275	2271	2018	598	2020	2020	1864	2384	2497	2497	2450	2220	2220		
Cover of herb layer (%)	40	50	20	40	20	40	15	30	70	15	25	20	30	50	35	45	45	15		
Relevé area (m ²)	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30		
pH	7.1	7	7	7.3	7.5	7.6	7.2	7.1	7.4	7.3	7	7.3	7.1	7.3	7.1	7.5	7.5	7.5		
Number of weeds	7	12	12	10	8	5	9	14	17	9	9	13	12	11	11	12	15	13		

Cultivated plants

<i>Solanum tuberosum</i>	3	3	3	3	3	2	5	2	.	2	.	3	2	2	2	2	3	3	
<i>Allium cepa</i>	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.
<i>Phaseolus vulgaris</i>	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.

Diagnostic species

Ass. *Brassica campestris-Lamietum amplexicauli*

<i>Lamium amplexicaule</i>	1	1	1	1	1	+	1	1	+	+	1	+	2	3	3	1	1	+	V
<i>Brassica campestris</i>	+	+	+	1	1	2	1	2	1	1	2	2	1	1	+	1	1	1	V

All. *Veronico-Euphorbion*, O. *Atriplici-Chenopodietalia albi* & Cl. *Stellarietea mediae*

<i>Chenopodium album</i>	.	2	1	1	1	+	+	+	+	.	+	1	1	1	1	3	2	1	V
<i>Convolvulus arvensis</i>	.	.	1	+	.	2	1	1	1	+	.	+	1	1	.	1	+	1	IV
<i>Capsella bursa-pastoris</i>	.	.	.	.	.	.	.	.	+	+	+	+	+	+	.	+	.	.	II
<i>Fagopyrum tataricum</i>	.	1	.	.	.	.	.	+	.	+	1	+	+	.	.	.	.	.	II
<i>Polygonum persicaria</i>	1	1	+	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II
<i>Lycopsis orientalis</i>	.	.	.	+	.	.	.	.	.	.	.	.	+	1	.	.	+	.	II
<i>Descurainia sophia</i>	.	.	.	+	.	.	.	.	+	.	.	.	.	.	+	1	.	.	II
<i>Sonchus oleraceus</i>	1	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	I
<i>Sisymbrium altissimum</i>	.	.	+	.	.	.	.	.	1	.	.	.	.	.	+	.	.	.	I
<i>Lepyrodiclis holosteoides</i>	.	.	.	.	+	.	.	.	.	.	.	.	.	1	+	.	.	.	I
<i>Lepidium latifolium</i>	.	.	.	.	.	.	.	+	.	1	.	.	.	.	.	.	.	+	I
<i>Polygonum aviculare</i>	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	+	.	.	I
<i>Setaria pumila</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	I
<i>Amaranthus blitum</i>	.	2	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I
<i>Chenopodium botrys</i>	.	+	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	I
<i>Asperugo procumbens</i>	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	I
<i>Sonchus asper</i>	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	I
<i>Malva neglecta</i>	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	I
<i>Euphorbia falcata</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	I
<i>Fallopia convolvulus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	I

Sporadic species: *Acroptilon repens* 14; *Chenopodium ficifolium* 1(3); *Chenopodium murale* 18; *Chenopodium rubrum* 4(2); *Conyza canadensis* 9; *Datura stramonium* 12; *Eruca sativa* 17; *Galinsoga parviflora* 12; *Hordeum leporinum* 9(1); *Hyoscyamus niger* 16; *Lathyrus cicera* 13(1); *Lithospermum arvense* 17; *Thlaspi arvense* 17; *Torilis leptophylla* 9(2); *Vaccaria hispanica* 2; *Veronica didyma* 9(1); *Vicia peregrina* 12.

Others

<i>Rumex crispus</i>	.	.	.	.	.	.	.	.	3	+	.	.	.	+	1	+	.	.	II
<i>Medicago sativa</i>	.	+	.	.	+	.	.	1	.	.	.	.	+	+	.	.	.	.	II
<i>Galium aparine</i>	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	+	+	.	II
<i>Arenaria serpyllifolia</i>	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	+	II
<i>Phragmites australis</i>	.	1	1	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
<i>Melilotus officinalis</i>	+	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	+	.	I
<i>Poa pratensis</i>	+	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
<i>Carum carvi</i>	.	.	+	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	I
<i>Taraxacum</i> sp.	.	.	.	+	.	.	+	.	.	.	.	.	+	.	.	.	.	.	I
<i>Astragalus tibetanus</i>	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	+	I

Tab. 2 (continued)

Successive number of relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Con.	
<i>Equisetum ramosissimum</i>	.	1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	I
<i>Mentha asiatica</i>	1	+	.	.	.	.	.	.	.	.	I
<i>Cichorium intybus</i>	.	.	.	+	.	.	.	+	I

Sporadic species: *Achillea millefolium* 3; *Artemisia absinthium* 8; *Artemisia persica* 18; *Artemisia vulgaris* 8; *Astragalus* sp. 5; *Barbarea arcuata* 9; *Bromus popovii* 9; *Equisetum arvense* 3(1); *Geranium rotundifolium* 11; *Lamium album* 15; *Medicago xvaria* 17(1); *Phleum graecum* 9(1); *Poa supina* 15; *Potentilla orientalis* 8; *Potentilla supina* 3; *Trifolium repens* 11; *Veronica arvensis* 9; *Veronica rubrifolia* 16.

Locality of relevé: 1 – (375739,9; 713158,1); 2 – (371829,2; 713014,9); 3 – (391054,1; 684328,7); 4 – (391054,1; 684328,7); 5 – (381834,9; 722842,4); 6 – (390948,2; 684818,2); 7 – (390948,2; 684818,2); 8 – (391401,9; 682546,8); 9 – (411751; 721232,9); 10 – (391401,9; 682546,8); 11 – (391401,9; 682546,8); 12 – (392207,6; 683827,9); 13 – (390256,2; 681914,9); 14 – (391135,1; 690518,5); 15 – (391135,1; 690518,5); 16 – (391135,1; 690518,5); 17 – (390322; 682054,8); 18 – (390322; 682054,8). Con – constancy.

Galium spurium, *Acroptilon repens*, *Lepyrodiclis holosteoides*, *Lycopsis orientalis* and others. As well, some ruderal species (e.g. *Melilotus officinalis*, *Descurainia sophia*, *Cichorium intybus*, *Bromus sterilis*, *Sisymbrium altissimum*, *S. loeselii*, *Galium aparine*, *Tribulus terrestris*) along with plants typical of riverbed vegetation (e.g. *Calamagrostis pseudophragmites*, *Equisetum ramosissimum*, *Pseudosophora alopecuroides*), dry grasslands (e.g. *Heliotropium ellipticum*, *Phleum graecum*, *Centaurea solstitialis*, *Filago vulgaris*), meadows and pastures (e.g. *Trifolium repens*, *T. pratense*, *Plantago major*, *Carum carvi*, *Poa pratensis*) or rushes (e.g. *Phragmites australis*, *Mentha asiatica*, *Bolboschoenus planiculmis*, *Rorippa palustris*, *Polypogon demissus*) occur within root crop communities. It is worth noticing that in the relevés obtained in the study area kenophytes (e.g. *Galinsoga ciliata*, *G. parviflora*, *Conyza canadensis*), with the exception of *Datura stramonium*, were noted rather sporadically.

As a result of the numerical classification of all of the relevés for root crop weed phytocoenoses, 8 groups were distinguished. These groups are identified as 7 associations and 1 community (respectively from the left to right part of the diagram): the *Brassico campestris-Lamietum amplexicauli*, *Galinsogo-Setarietum*, *Convolvulo arvensis-Cyperetum rotundi*, *Datura stramonii-Hibiscetum trioni*, *Equiseto arvensi-Xanthietum italici*, *Portulacetum oleracei*, and *Setario pumilae-Sorghetum halepensi* associations, and a community with *Chrysanthemum coronarium* (Fig. 3).

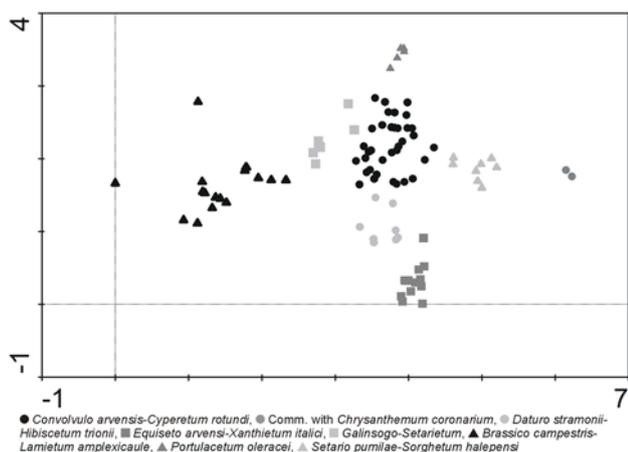


Fig. 3 DCA ordination for all samples of segetal communities (N = 107).

The DCA ordination run for the entire data set clearly segregates the association described as new to science (*Brassico campestris-Lamietum amplexicauli*) as well as other associations. The reason for this is, of course, the essential differences in the floristic composition and structure of individual phytocoenoses. Only plots closely related in terms of habitat conditions, such as some phytocoenoses of *Convolvulo-Cyperetum*, *Galinsogo-Setarietum* and *Datura-Hibiscetum*, are not clearly distinguishable one from another. This is probably due to the irrigation of the fields in which they appear and the occurrence of common species of wet habitats such as *Plantago major*, *Polygonum aviculare* and *Cyperus rotundus*.

Syntaxa of the root crops in Tajikistan

CONVOLVULO ARVENSIS-CYPERETUM ROTUNDI
Carretero et Aguilera ex Ninot, X. Font, Masalles et Vigo 2010–2011 (Tab. S1, rel. 1–39).

Diagnostic species: *Cyperus rotundus*.

The *Convolvulo arvensis-Cyperetum rotundi* association is among those particularly common in Tajikistan. Phytocoenoses dominated by, or featuring a high share of, *Cyperus rotundus* developed mostly in middle sections of alpine rivers of the study areas, among others, the Syr Darya, Pasrud Darya, Yagnob, Zeravshan, Kafirnighan and Vakhsh Rivers, mostly at altitudes of ca. 700–900 m. *Convolvulo arvensis-Cyperetum rotundi* occurs mainly in maize, potato, tomato, cotton, leek and, rarely, in parsley plantations. The association develops in moist and fertile, brown soils with close to neutral reactions (pH approx. 7.3; Fig. 4). Fields are in most cases irrigated. *Cyperus rotundus* is not always apparently dominant; however, in a few plots, the cover of this diagnostic species exceeds 40%. The mean cover value of *Cyperus rotundus* is ca. 10–20%. In phytocoenosis, which is relatively rich in species, ca. 14 taxa have been noted on average. Co-occurring species represent mainly the *Atriplici-Chenopodietalia albi* order and the *Stellarietea mediae* class, e.g. *Echinochloa crus-galli*, *Chenopodium album*, *Convolvulus arvensis*, *Setaria viridis*, *Amaranthus retroflexus*, *Sonchus oleraceus*, *Polygonum aviculare*, the *Eragrostietalia* order, e.g. *Portulaca oleracea*, *Cynodon dactylon* and cereal communities, e.g. *Avena trichophylla*. The phytocoenosis is also supported by species typical for moist ruderal communities such as *Polygonum aviculare* (Tab. S1). Within *Convolvulo arvensis-Cyperetum rotundi*, due to a significant share of *Kochia scoparia*, the subassociation of *Ca-Cr kochietosum scopariae* subass. nova has been distinguished (*Typus* relevé – Tab. S1, rel. 34; locality:

Tab. 3 *Portulacetum oleracei*.

Successive number of relevé	1	2	3	4	5	Number of occurrence
Day	10	30	10	10	7	
Month	9	5	9	9	9	
Year	2011	2011	2011	2011	2011	
Altitude (m)	950	816	772	850	886	
Cover of herb layer (%)	65	70	60	40	70	
Relevé area (m ²)	30	30	30	30	30	
pH	7.2	7.2	7.4	7.5	7.2	
Number of weeds	16	14	16	15	10	
Cultivated plants						
<i>Solanum tuberosum</i>	3	3	3	4	.	
<i>Lycopersicon esculentum</i>	.	.	.	.	3	
<i>Citrullus lanatus</i>	.	.	.	.	1	
Diagnostic species						
Ass. <i>Portulacetum oleracei</i>						
<i>Portulaca oleracea</i>	4	4	4	3	4	5
All. <i>Eragrostion cilianensi-minoris</i>, O. <i>Eragrostietalia</i> & Cl. <i>Stellarietea mediae</i>						
<i>Amaranthus retroflexus</i>	+	+	+	1	1	5
<i>Cirsium incanum</i>	+	+	+	+	+	5
<i>Chenopodium album</i>	+	1	1	1	.	4
<i>Cyperus rotundus</i>	1	1	+	+	.	4
<i>Veronica persica</i>	+	1	1	+	.	4
<i>Polygonum aviculare</i>	+	+	+	1	.	4
<i>Sinapis arvensis</i>	+	+	+	+	.	4
<i>Anthemis altissima</i>	1	1	+	.	.	3
<i>Hibiscus trionum</i>	1	1	.	+	.	3
<i>Setaria pumila</i>	+	.	+	+	.	3
<i>Convolvulus arvensis</i>	+	.	.	.	1	2
<i>Setaria viridis</i>	.	+	.	.	1	2
<i>Echinochloa crus-galli</i>	.	.	.	+	+	2
Sporadic species: <i>Amaranthus blitum</i> 5; <i>Amaranthus lividus</i> 3; <i>Anagallis foemina</i> 4; <i>Chenopodium botrys</i> 4; <i>Cynodon dactylon</i> 5(1); <i>Malva neglecta</i> 5(1); <i>Solanum nigrum</i> 3; <i>Sorghum halepense</i> 1; <i>Xanthium italicum</i> 3.						
Others						
<i>Medicago lupulina</i>	+	+	+	+	.	4
<i>Melilotus indicus</i>	+	+	+	+	.	4
<i>Rumex halacsyi</i>	+	+	+	.	.	3
Sporadic species: <i>Plantago major</i> 5.						

Locality of relevé: 1 – (383447,8; 684232,3); 2 – (383447,8; 684232,3); 3 – (383447,8; 684232,3); 4 – (383447,8; 684232,3); 5 – (395659,8; 690005,1).

383310,2; 683410,5; date: 2011.05.30; altitude: 848 m; cover of herb layer: 35%; relevé area: 30 m²; pH: 7.4; number of weeds: 15; cultivated plant: *Solanum tuberosum* 4; diagnostic species: Ass. *Convolvulo arvensis-Cyperetum rotundi* – *Cyperus rotundus* 1; SubAss. *Convolvulo arvensis-Cyperetum rotundi kochietosum scopariae* – *Kochia scoparia* 2; O. *Atriplici-Chenopodietalia albi* & Cl. *Stellarietea mediae* – *Convolvulus arvensis* 1, *Portulaca oleracea* 1, *Chenopodium album* +, *Amaranthus retroflexus* +,

Cynodon dactylon 1, *Polygonum aviculare* +, *Sinapis arvensis* +, *Veronica persica* +, *Galinsoga ciliata* +; others – *Plantago major* +, *Lolium perenne* +, *Rorippa palustris* +, *Helianthus tuberosus* +). *Kochia scoparia* in Tajikistan occurs in segetal as well as ruderal habitats; however, it creates frequent and constant compositions in segetal root-crop communities on sandy soils and fields close to road or railway verges, cities or villages.

DATURO STRAMONII-HIBISCETUM TRIONI Bagrikova (1996) 1997 (Tab. S2, rel. 1–12).

Diagnostic species: *Hibiscus trionum*, *Datura stramonium*.

Plots of this association have been observed spread mainly over the southern Tajikistan and Prisyrdaryan geobotanical regions. They are typified by loose cultivation of maize, cotton, lentils, onions, beans and, sporadically, carrots. The phytocoenoses were recorded within a range of altitudes from ca. 700 to 1000 meters above sea level (Fig. 4). The community prefers warm, deep, brown soils with inconsiderable gravel or sand content. The reaction of the substrate was neutral or slightly alkaline [pH 7.0–7.3 (7.7)]. Fields are often irrigated. In a single plot, between 10 and 20 species were noted. The average number of species per relevé was 14. The maximum cover of weed species in the phytocoenoses was about 65%, or, in most cases, ca. 45%. Besides diagnostic species, this association is characterized by a high share of meadow or pasture species including *Cynodon dactylon*, *Plantago major*, and *Polygonum persicaria*. This is mainly because of the irrigation of the plantations. To the most constant taxa belong *Amaranthus retroflexus*, *Abutilon theophrasti*, *Convolvulus arvensis*, *Solanum nigrum*, *Portulaca oleracea* and *Xanthium italicum*. The diagnostic taxa generally prefer warm sites throughout the area of their occurrence in the east Mediterranean-Irano-Turanian region within medium-height mountainous locations.

SETARIO PUMILAE-SORGHETUM HALEPENSI Ștefan et Oprea 1997 (Tab. S2, rel. 13–20).

Diagnostic species: *Sorghum halepense*, *Setaria pumila*.

The association occurs sporadically in the southern Tajikistan geobotanical region. It prefers medium elevations, that is, altitudes of 800 to 1000 meters above sea level (Fig. 4). The association develops mainly in potato and lentil cultivations. Its phytocoenoses are associated with fertile, relatively dry, neutral or slightly alkaline soils, often with high sand content and quite loose. Between 10 and 20 species were recorded in a single plot (mean approx. 15). The phytocoenoses of *Setario pumilae-Sorghetum halepense* association are characterized by a relatively high cover of herb layer. The maximum cover of weed species in the phytocoenoses was about 85%. The mean cover of the whole “c” layer was ca. 65–70% (Fig. 4). The diagnostic *Sorghum halepense* has relatively high cover in all plots. To the most abundant and constant species found in phytocoenoses belong *Xanthium italicum*, *Helianthus tuberosus*, *Echinochloa crus-galli* and *Cyperus rotundus*. Cereal crop species from the *Turgenio-Roemerietalia refractae* order such as *Avena trichophylla* or *Cirsium incanum* were also noted in observed plots.

EQUISETO ARVENSI-XANTHIETUM ITALICI Kolev 1976 (Tab. S2, rel. 21–33).

Diagnostic species: *Xanthium italicum*.

The association is very distinct from other segetal weed communities noted in Tajikistan (Fig. 3). It is associated mainly with maize, lentil, potato, sunflower, and tomato fields situated at medium elevations within an altitudinal range of

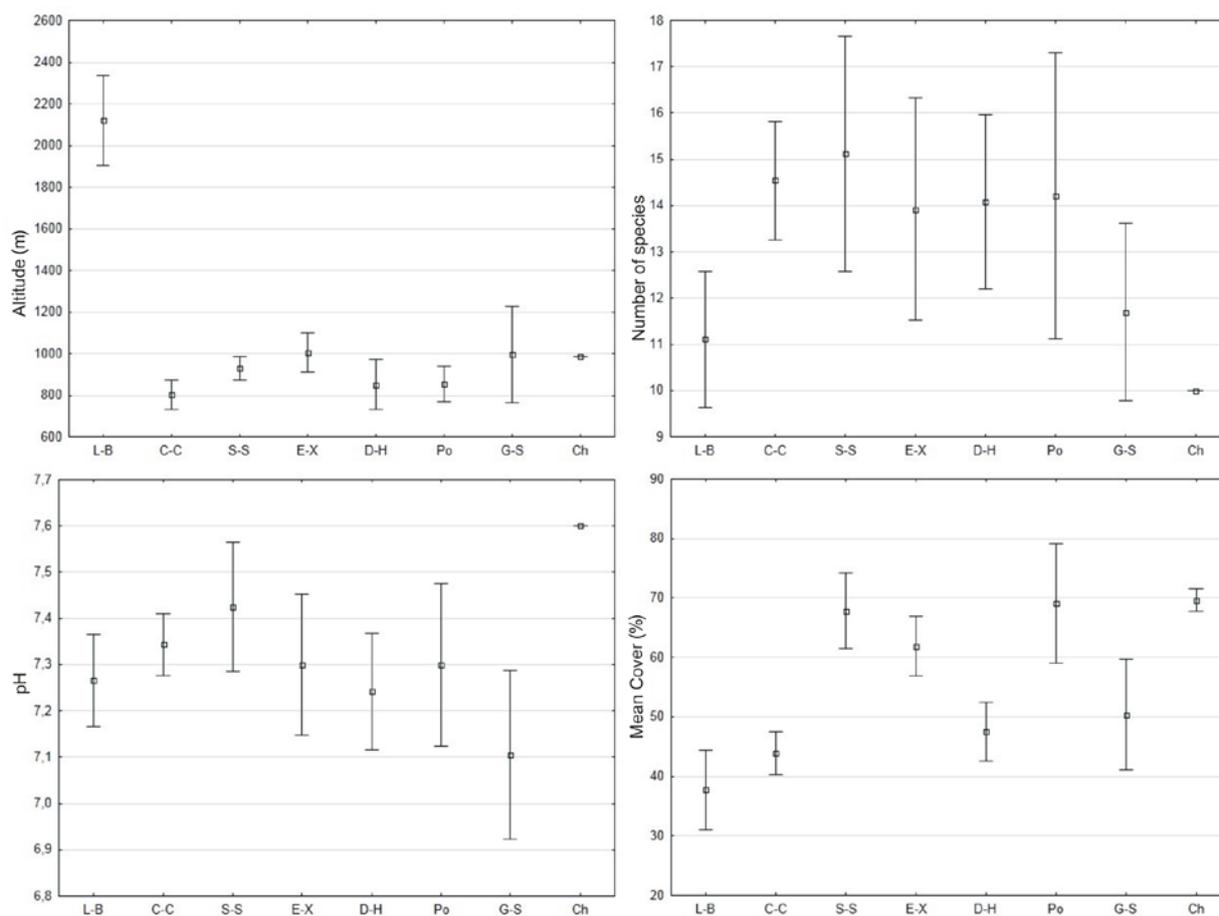


Fig. 4 Altitudinal distribution, richness, pH and mean cover of weeds in researched vegetation plots of *Brassica campestris-Lamietum amplexicauli* (L-B), *Convolvulo arvensis-Cyperetum rotundi* (C-C), *Setario pumilae-Sorghetum halepensi* (S-S), *Equisetum arvensis-Xanthietum italici* (E-X), *Daturo stramonii-Hibiscetum trioni* (D-H), *Galinsoga-Setarietum* (G-S), *Portulacetum oleracei* (Po) and community with *Chrysanthemum coronarium* (Ch).

800 to 1180 meters above sea level (Fig. 4). The association develops on relatively dry, sandy soil, or soil with significant stone content or gravel fraction substrates. The soil is neutral or slightly alkaline [pH 7.0–7.5(7.8)], moderately fertile, and sporadically irrigated. Plots of the association are moderately rich in species, containing from 10–24 taxa (mean approx. 14). The total cover of weed species in the phytocoenoses rarely exceeds 80%, and in most cases it fluctuates around 60% (Fig. 4). Typical for the observed plots was the relatively significant cover of the diagnostic species *Xanthium italicum*, which attains an average value of approx. 30–35%. Among the species with the highest constancy are *Setaria viridis*, *Galium spurium*, *Echinochloa crus-galli*, *Cichorium intybus*, *Chenopodium album* and *Convolvulus arvensis*. In several plots, due to the irrigation, considerable cover of *Cynodon dactylon* was found. Also, the *Cuscuta campestris* which parasitise *Xanthium italicum* have significant cover in few plots.

COMMUNITY WITH *CHRYSANTHEMUM CORONARIUM* (Tab. S2, rel. 34–35).

Diagnostic species: *Chrysanthemum coronarium*.

The community with *Chrysanthemum coronarium* is extremely rare in Tajikistan. Plots of this community were found only in one location in the Vakhsh river valley at the altitude of ca. 1000 meters above sea level (Fig. 4). It has been noted in *Lens culinaris* and *Solanum tuberosum* plantations on deep, brown, loessic and slightly alkaline soil. The substrate was

generally dry; however, it is supposed that the field undergoes irregular irrigation. Only 10 species were recorded in the relevés; thus, the association is among the poorest (Fig. 4). The diagnostic taxon has been observed in both plots, with considerable cover of 55–60%. The total cover of weed species in the phytocoenoses does not exceed 65%. The association is characterized by a high proportion of *Stellarietea mediae* species, e.g. *Setaria viridis*, *Chenopodium album*, *Amaranthus retroflexus*, *Sorghum halepense* or *Cyperus rotundus* (Tab. S2, rel. 34–35). Also, taxa typical for cereal crop vegetation from the *Turgenio-Roemerietalia refractae* order were noted in phytocoenoses (e.g. *Anthemis altissima*, *Avena trichophylla*). This is related to the crop rotation cycle and the proximity of cereal and root crops.

GALINSOGA-SETARIETUM (R. Tx. et Beck. 1942) R. Tx. 1950 (Tab. 1, rel. 1–7).

Diagnostic species: *Galinsoga parviflora*, *Galinsoga ciliata*.

The association was found in only a few places in Tajikistan, in sandy fields, mainly around Dushanbe in the southern Tajikistan region. Plots of the phytocoenosis were noted at altitudes of ca. 1000–1200 meters above sea level (mean approx. 1180; Fig. 4). The association was found mostly in potato cultivations. Its phytocoenoses are associated with moderately fertile, mesic dry and neutral (pH 6.8–7.2) brown soils, which contain a high percentage of sand or gravel fractions. The researched plots were species-poor, containing on average approx. 13 species

in a single patch. The phytocoenoses of *Galinsoga-Setarietum* are characterized by a relatively high cover of herb layer due to the considerable domination of *Galinsoga parviflora*, *Kochia scoparia* or *Oxalis fontana*. Apart from diagnostic species, plots of this association often include *Sonchus oleraceus*, *Plantago lanceolata*, *Polygonum persicaria*, *Trifolium repens* and *Polygonum aviculare* (Tab. 1).

BRASSICO CAMPESTRIS-LAMIETUM AMPLEXICAULI ASS. NOVA (Tab. 2, rel. 1–18).

Typus relevé: Tab. 2, rel. 14.

Diagnostic species: *Lamium amplexicaule*, *Brassica campestris*.

The association is the least thermophilous syntaxon of all those recorded in root crops in Tajikistan. It occurs mostly in the Zeravshanian, Hissar-Darvasian and eastern Tajikistanian geobotanical regions at relatively high altitudes, from generally 1900 to 2500 meters above sea level (mean approx. 2100; Fig. 4). The association develops mainly in potato cultivations. Its phytocoenoses are associated with unfertile, neutral or moderately alkaline, grey soils and rankers, which are often very stony and loose. Recorded plots were sometimes observed on northern slopes of alpine river valleys (e.g. Yagnob, Pastrud Darya, Iskander Darya) or on northern rock walls. Between 5 and 17 weeds were recorded in a single plot (mean approx. 11). The plots of the *Brassico campestris-Lamietum amplexicauli* association are characterized by a relatively low cover of herb layer. The maximum cover of weed species in the phytocoenoses was about 70%. The mean cover of the whole “c” layer was ca. 35% (Fig. 4). Co-occurring species generally represent root-crop weeds (e.g. *Chenopodium album*, *Sonchus oleraceus*). However, there is also a relatively considerable share of cereal-crop field species (e.g. *Fagopyrum tataricum*, *Lepyroclis holosteoides*, *Torilis leptophylla*). These phytocoenoses are also supported by species typical for ruderal habitats, like *Sisymbrium altissimum* or *Melilotus officinalis* (Tab. 2).

PORTULACETUM OLERACEI Felföldy 1942 (Tab. 3, rel. 1–5). Syn.: *Digitario-Portulacetum* (Felföldy 1942) Timár et Bodrogk. (1953) 1955; *Convolvulo-Portulacetum* Ubrizsy 1949, 1950).

Diagnostic species: *Portulaca oleracea*.

The association of *Portulacetum oleracei* is among the most widely distributed in Tajikistan. However, within vegetable crops it was found sporadically. Phytocoenoses dominated by *Portulaca oleracea* developed mostly at middle elevations of river valleys in the southern Tajikistanian and Prisyrdaryan geobotanical regions, mostly at altitudes of ca. 750–950 meters above sea level. *Portulacetum oleracei* occurs mainly in potato plantations. The association develops on moist and fertile, deep, brown soils with a relatively high content of sand or gravel. The substratum is close to neutral (pH approx. 7.2–7.5; Fig. 4). Fields are located in sunny places and sometimes irrigated. *Portulaca oleracea* is always apparently dominant. The cover of this diagnostic species exceeds 60%. The phytocoenoses of the association feature significant total cover of weeds, more than 70%. In phytocoenoses relatively rich in species, ca. 14 taxa have been noted on average. Co-occurring species represent segetal (e.g. *Echinochloa crus-galli*, *Chenopodium album*, *Setaria viridis*, *Amaranthus retroflexus*, *Veronica persica*) or ruderal (e.g. *Melilotus indicus*, *Malva neglecta*, *Amaranthus blitum*, *Cynodon dactylon*) vegetation (Tab. 3).

Synopsis of syntaxa

Based on this study, we propose the following classification of the weed communities of root crops in Tajikistan:

Stellarietea mediae Tüxen et al. ex von Rochow 1951

Atriplici-Chenopodietalia albi R. Tüxen (1937) Nordhagen 1940

Spergulo arvensis-Erodion cicutariae J. Tüxen in Passarge 1964

[Syn. *Panico-Setarion* Sissingh in Westhoff, Dijk et Passchier 1946 – §2b, nomen nudum; *Digitario-Setarion* (Sissingh in Westhoff et al. 1946) Hüppe et Hofmeister 1990]

1. *Convolvulo arvensis-Cyperetum rotundi* Carretero et Aguilera ex Ninot, X. Font, Masalles et Vigo 2010–2011

– *Convolvulo arvensis-Cyperetum rotundi kochietosum scopariae* S. Nowak & A. Nowak subass. nova

2. *Daturo stramonii-Hibiscetum trioni* Bagrikova (1996) 1997

3. *Setario pumilae-Sorghetum halepensi* Ştefan et Oprea 1997

4. *Equiseto arvensi-Xanthietum italici* Kolev 1976

5. Comm. with *Chrysanthemum coronarium*

Oxalidion fontanae Passarge 1978

(Syn. *Spergulo-Oxalidion* Görs in Oberdorfer et al. 1967 – §2b, nomen nudum; *Polygono-Chenopodion polyspermi* sensu auct. non Koch 1926 – pseudonym)

6. *Galinsoga-Setarietum* (R. Tx. et Beck. 1942) R. Tx. 1950

Veronico-Euphorbion Sissingh ex Passarge 1964

(Syn. *Veronico-Euphorbion* Sissingh 1942 – ms. §1; *Fumario-Euphorbion* Müller ex Görs 1966)

7. *Brassico campestris-Lamietum amplexicauli* S. Nowak & A. Nowak ass. nova

Eragrostietalia J. Tüxen ex Poli 1966

Eragrostion cilianensi-minoris Tüxen ex Oberdorfer 1954

(Syn. *Amarantho-Chenopodion albi* Morariu 1943 – §3b; *Eragrostenion* Tüxen 1950 – §2b, nomen nudum, suballiance; *Panico-Setarion* Sissingh ex von Rochow 1951 – §36, nomen ambiguum; *Tribulo-Eragrostion poaeodis* Soó et Timár in Timár 1957; *Eragrostio-Polygonion arenastri* Couderc et Izco ex Čarni et Mucina 1998; *Euphorbion prostratae* sensu Mucina in Mucina et al. 1993 non Rivaz-Martínez 1976 – pseudonym)

8. *Portulacetum oleracei* Felföldy 1942

Discussion

So far, few studies concerning segetal weeds in Tajikistan have been published, and the existing publications were issued quite a long time ago (e.g. [100]). To discover distribution patterns and the species richness of Tajikistan's segetal flora, a reconnaissance field study and a research query were conducted in the years 2008–2010. As a result of the analyses, it was determined that Tajikistan's segetal flora consists of 689 taxa. The most weed-abundant families include Fabaceae, Asteraceae, Chenopodiaceae, Lamiaceae, Boraginaceae and Brassicaceae. The most weed-rich regions of the country are the southwestern areas, i.e. the southern Tajikistanian geobotanical region where over 500 species were observed. Also, the Hissar-Darvasian,

Prisyrdaryan and Zeravshanian regions, where approx. 350 weed species occur, are also rich in segetal flora. As regards vertical distribution, the largest weed species richness was observed within the range of 800 to 1700 meters above sea level. Due to very extensive agriculture as well as relatively small fields, weed occurrence is frequent outside segetal communities in Tajikistan. Weeds were usually noted in riverbed gravels, screes, wastelands, rushes, xerothermic grasslands and in typical ruderal communities [101]. The richness of the segetal communities is clearly visible when the number of species in separate patches of vegetation, with up to 50 taxa per plot in crop cultivations, is considered. The total number of species detected in the data set as a whole is significant. This is relatively rich flora when compared to other crop cultivation areas in the world (e.g. [35,36,39,50,71,102]).

The floristic structure and separateness of the community makes it necessary to distinguish a new association: *Brassico campestris-Lamietum aplexicauli*. This is one of the most interesting phytocoenoses occurring in the highest elevations occupied by root-crop cultivations in the Pamir Alai Mts (ca. 1900–3000 meters above sea level). The association corresponds with another typically mountainous segetal community known from cereal-crop fields of the Middle Asia: *Fagopyro tatarici-Lathyretum sativi* [83]. Both associations have developed on similar soils and have many species in common, such as: *Brassica campestris*, *Fagopyrum tataricum*, *Lepyroclis holosteoides* or *Torilis leptophylla*. However, the cereal association has a clearly narrower range, being restricted to the eastern Pamir.

Another interesting root-crop association is *Convolvulo arvensis-Cyperetum rotundi* Carretero et Aguilella ex Ninot, X. Font, Masalles et Vigo 2010–2011. This phytocoenosis is apparently related to irrigated fields and has the greatest share in cotton plantations. The association was described as a weed community chiefly formed by geophytes like *Cyperus rotundus* and *Convolvulus arvensis* and including other generalist ruderals like *Portulaca oleracea*, *Amaranthus blitum* or *A. retroflexus* [97]. Although it has been suggested that the community develops under a cultivation regime of low intensity, including irrigation, it seems obvious that compared to a more continental climate (e.g. littoral Mediterranean conditions in Spain), in Tajikistan the association needs quite intensive irrigation. It is one of the most widespread segetal plant associations in Tajikistan. Because of the abundant occurrence of *Cyperus rotundus* it could be compared to *Setario ambiguae-Cyperetum rotundi* Brullo, Scelsi & Spampinato 2001 from Sicily, which also occurs in alluvial, moist soils within the thermo- and mesomediterranean bioclimatic belts, but generally in citrus groves [45]. It could be also compared to *Digitario sanguinalis-Cyperetum rotundi* Bergmeier 2008, known from sandy or loamy-sandy alkaline soils from citrus cultivations in Crete [103].

As *Convolvulo arvensis-Cyperetum rotundi* has frequently been found in Europe in ruderal habitats or fields and orchards close to disturbed biotopes, a subassociation characterized by a considerably high share of *Kochia scoparia* could be distinguished. In researched plots in Tajikistan several relevés are dominated by *Kochia scoparia*; thus it seems plausible to separate the new syntaxon at the lowest rank as a segetal phytocoenosis closely related to communities from the *Atriplicion* alliance (e.g. [95,97,104–106]).

Another thermophilous association typical for arable root crop cultivations is *Daturo stramonii-Hibiscetum trioni* Bagrikova (1996) 1997. It has been recently described from vineyards of Crimea [96] as a species-poor community from

the *Atriplici-Chenopodietalia albi* order. Considering the floristic structure, habitat conditions and climatic circumstances, the plots from Tajikistan are truly comparable to those reported from Crimea. The difference is in cultivated plants, as in Tajikistan the *Daturo stramonii-Hibiscetum trioni* association was found mainly in plantations of maize, cotton, lentils, onions, and beans, but not of potatoes. Also, the share of *Cynodon dactylon* is higher here, making the plots similar to *Hibisco trioni-Cynodontetum* Kolev 1976 described from the Balkans [50]. However, this species has broader ecological amplitude in the Middle Asia, is not typical for segetal vegetation and its presence and abundance depends mainly on irrigation and trampling by cattle after harvest of the cultivation crop. Therefore, *Cynodon dactylon* seems not to be an appropriate diagnostic species for the association or alliance. This species, as well as other C4 grasses, have been reported as diagnostic for the ruderal and sometimes also segetal syntaxa from the *Eragrostion cilianensi-minoris* alliance typical for warm synanthropic habitats with sandy or gravelly soils. The studies of Čarni & Mucina [107], Kropač [108], Borhidi [109], Sanda et al. [47], Lososova et al. [36] and Němec et al. [110] have revealed the *Hibisco trioni-Eragrostietum poaeoidis* Soó et Tímár 1957 to be a rare association inhabiting arable fields mainly containing root crops, trampled habitats and recently disturbed synanthropic sites in Central Europe and the Balkans. However, due to a colder and wetter climate, the syntaxon has a higher level of participation of Eurosiberian or Boreal species in comparison to plots found in Tajikistan, where Irano-Turanian and Mediterranean taxa clearly prevail.

Several relevés have been identified as *Portulacetum oleracei* Felföldy 1942. This is a commonly occurring association throughout the eastern Mediterranean and Irano-Turanian provinces, known from vineyards, lavender, root crops and cotton plantations as well as orchards and vegetable gardens [47,94,96,109,111]. In Tajikistan it develops mainly in poorly managed vegetable gardens with the lowest cultivation intensity. In these plots the crop cover is relatively low; thus the total weed cover can attain high values. The *Portulacetum oleracei* association has a rather insignificant share of ruderal species, such as *Malva neglecta*, *Amaranthus lividus*, or *A. blitum*. The association is confined to sunny places, close to ruderal habitats, with sandy substrata, often well supplied with water (irrigation) and nitrates.

Equiseto arvensi-Xanthietum italici Kolev 1976 develops on moderately fertile, often sandy or gravelly soils. The association was described from sandy fields in Bulgaria [50]. Despite the absence of *Equisetum arvense*, which has a different ecological amplitude in Tajikistan (occurring mainly in bogs and riverside forests), plots with abundant occurrence of *Xanthium italicum* have been identified as *Equiseto-Xanthietum italici* because of floristic and habitat similarities to phytocoenoses known from the Balkans. The association shows a relative preference for the driest locations; however, it has also been observed in plots under an irrigation regime. *Xanthium italicum* prefers such unstable and changing moisture conditions. The species is regarded as diagnostic to associations typical for inundated river alluvials such as *Xanthio strumarium-Bidentetum* Tímár 1947 from the *Bidentetea* class [47].

Another association occurring on relatively dry substrates is *Setario pumilae-Sorghetum halepensi* Ștefan et Oprea 1997. It is known from Romania and adjacent areas where it grows in irrigated fields, mainly root crops. In Tajikistan the association develops sporadically in the southern Tajikistanian geobotanical

region. As in Europe, it is a rather species-poor association apparently dominated by grass species such as diagnostic *Sorghum halepense* or *Setaria pumila*. There is still a need to explore the communities of *Sorghum halepense* in more detailed studies and find its relation to other associations, such as *Chondrilla juncea*-*Sorghum halepense* Kolev 1976 (described from cereals in the Balkans [50]) or *Hibisco trioni*-*Sorghum halepense* (described from Dalmatia [112]). Also, *Galinsoga*-*Setarietum* merits further research in Tajikistan focusing especially on the syntaxonomical position of this community. Temporarily, it was classified to the *Oxalidion fontanae* alliance Passarge 1978 (*Polygono-Chenopodium polyspermi* sensu auct. non Koch 1926 – pseudonym) because of its considerable share of *Oxalis fontana*, *Sonchus oleraceus* and *Veronica persica*. However the significant participation of *Setaria pumila* and *S. viridis* renders the association similar to *Setario pumilae*-*Echinochloëtum cruris-galli* Felföldy 1942 corr. Mucina in Mucina et al. 1993 (syn. *Setario glaucae*-*Galinsogetum parviflorae* Tüxen 1950) classified in *Spergulo arvensis-Erodion cicutariae* J. Tüxen in Passarge 1964 (syn. *Panico-Setarion*).

Other root-crop associations play a minor role in segetal habitats of Tajikistan; however, they significantly contribute to the diversity of agrocoenoses. There is still a need for further research in root-crop communities of Tajikistan and the Middle Asia. Some of the above-mentioned syntaxa (e.g. *Brassico-Lamietum* or *Convolvulo-Cyperetum*) are significantly diversified in terms of floristic structure; hence, after collection of more data or enlargement of the survey area, it would seem possible to describe new syntaxa with at least subassociation rank. Taking more relevés may help to classify the community of *Chrysanthemum coronarium* and to discover its relation to *Asphodelo fistulosi*-*Hordeetum leporini* O. Bolòs 1956 *chrysanthemetosum coronarii*, *Resedo albae*-*Chrysanthemetum coronarii* O. Bolòs et Molinier 1958 or *Malvo parviflorae*-*Chrysanthemetum coronarii* Ferro 1980 [113–115]. Chorological analyses and conservation considerations will also be of great importance in discovering the present distribution patterns of weed flora of Tajikistan.

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Authors' contributions

The following declarations about authors' contributions to the research have been made: field research, idea and manuscript preparation: SN; field research: ASN.

Supplementary material

The following supplementary material for this article is available online at <http://pbsociety.org.pl/journals/index.php/asbp/rt/suppFiles/1365/0>:

1. Tab. S1 *Convolvulo arvensis-Cyperetum rotundi*.
2. Tab. S2 Associations and communities of the *Spergulo arvensis-Erodion cicutariae* alliance.

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