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Generative reproduction efficiency and the population age structure of *Rumex confertus* Willd.

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S u m m a r y

Rumex confertus is one of the alien species vigorously entering native meadow as well as ruderal communities in major river valleys. In about a hundred years the species invaded almost the whole territory of Poland. Many reports stating that Russian Dock may reach high coverage in various phytocoenoses contradict those of its low generative reproduction efficiency.

In communities where it most frequently occurs, germination is hindered by the lack of empty spaces. In such conditions the population size remains stable due to vegetative reproduction. Only hay-growing meadows seem to promote the influx of new genets into population, which is likely associated with vegetation cover removal and periodic reduction of competition from other species.

Key words: *Rumex confertus* Willd., generative reproduction, reproduction efficiency, population age structure

INTRODUCTION

Russian Dock (*Rumex confertus* Willd.) is no doubt one of the most invasive alien species in the flora of Poland. This Asiatic plant invades mainly these phytocoenoses which are susceptible to new species penetration. It may create local populations of high density, and sometimes becomes a main and constitutive component of the community.

In the country scale it can be most frequently found in the communities of hay-growing meadows in river valleys, where it can reach high coverage. The species

penetrates mainly altered phytocoenoses of the alliance *Arrhenatherion elatioris* (Faliński, 1998; Pyšek et al. 2002) and *Alopecurion pratensis* (Soó, 1964; Kępczyński and Rutkowski, 1992). It enters also ruderal communities of *Artemisio-Tanacetum vulgaris* (Soó 1964; Faliński, 1998; Jehlik et al. 2001; Pyšek et al. 2002), though with less intensity. As is quite natural, ruderal communities are composed of many invasive alien species. Hay-growing meadows represent semi-natural communities composed mainly of native species. High participation of Russian Dock, a species of little value, may considerably reduce the fodder quality of hay.

Rhizomes of Russian Dock, a species akin to *Rumex obtusifolius* and *R. crispus,* grow every year. In course of time the plant forms clumps which are made of many units: generative shoots and vegetative rosettes. Such expanded, multi-module specimens, easily noticed from a distance, are taken into account in floristic or phytosociological studies.

In few reports concerning population age structure of Russian Dock, the authors pointed out the lack or low participation of plants at early development stages (Rabotnov and Bylova, 1980; Ćwikliński, 1990).

Until now the studies of generative reproduction of the species were conducted only within its natural distribution range: in the valley of Oka (Almazova and Rabotnov, 1953; Rabotnov and Bylova, 1980). According to these authors, the seedlings that appeared in spring in local hay-growing meadows withered away quickly and only a few reached next development stages.

The knowledge of generative reproduction efficiency and population age structure makes it possible to determine the dynamics of the population and to predict its future.

The aim of the study is determining generative reproduction efficiency and age structure of various populations of *Rumex confertus* as well as defining the factors influencing these population features.

MATERIAL AND METHODS

The material was collected in the years 1999 2003.

In this work the concept of coenotic population, defined as a set of individuals of a species in a given phytocoenosis, was assumed. According to this approach, distinguished patches are referred to as coenopopulations. Spatially well isolated genets (sensu Harper, 1977) were treated as „specimens". Because of their clonal growth particular genets can be single individuals or, especially old clumps, they can represent a vegatatively formed collection of individuals (Falińska, 1977, 2001; Harper, 1985; Lembicz, 1998).

Three different, spatially isolated phytocoenoses with a high participation of R*umex confertus* Willd were selected for the study. They were located on the left bank of Vistula river, between Bydgoszcz and Świecie. These were: an extensively used periodically flooded meadow, a vegetation strip on a slope adjoining the river-bed and a side-space of an unpaved road surrounded by plough-lands.

The meadow coenopopulation (A) occurring in a community of the alliance *Alopecurion pratensis* is characterized by a high density of *Rumex confertus* genets. The density of the species in two ruderal phytocoenoses (coenopopulations B and C) is significantly lower.

The investigated areas differ not only in community types developed there and participation of Russian Dock in their structure, but also in soil granulation. The sum of exchangeable basic cations is correlated with the amount of floatables in the soil: it reaches the highest value for dusty clay in the coenopopulation A. In all cases the pH values are characteristic of basic reaction soils. The soil in each coeonopopulation is rich in nitrogen and humus, and, with the exception of coenopopulation C, contains little phosphorus and assimilable potassium.

Permanent plots (rectangles of the area of 128 m^2) were delimited in these areas in autumn 1999. Selected development stages (G a t s u k et al. 1980) were mapped in the scale 1:100 (K w i a t k o w s k a and S y m o n i d e s , 1980). Seedling density was determined in a 1 m width transect located in the middle of each plot.

Experimental ranges with plant cover removed were set up close to the permanent plots. To investigate germination and development of seedlings one thousand seeds were sown there in autumn 2001 (experiment 1) and 2002 (experiment 2). The experiments were repeated three times. Sprouting and development of genets were first checked every second week, then once a month; seedlings of other species were being removed.

The survival rate at young age in described coenopopulations was illustrated with survival index which shows a decrease in relative number of individuals at subsequent development stages. Their spatial pattern and its changes in time were determined using Lexis index.

RESULTS

The meadow coenopopulation (A) was the only permanent plot where a few seedlings per 10 m^2 were found. Since the lack of so called safe germination sites is probably a limiting factor for sprouting and further development, analyses of survival rate at early development stages were conducted in areas with vegetation cover removed.

Vigorous sprouting was observed in mid April, before other species in particular communities resumed vegetation. This lasted up to 10 days, and then new seedlings ceased to appear. Only a few percent of sown seeds germinated. The maximum germination rate was >9% in the meadow coenopopulation in 2003. Seedlings developed slowly, reaching the juvenile phase gradually. Simultaneously in June a rapid decrease in the number of young genets was noticed, which eventually in 2002 led to their elimination in populations B and C. In the meadow, in spite of a significant decrease in seedling number, half of them continued to grow. Subsequent winter periods did not reduce their number considerably.

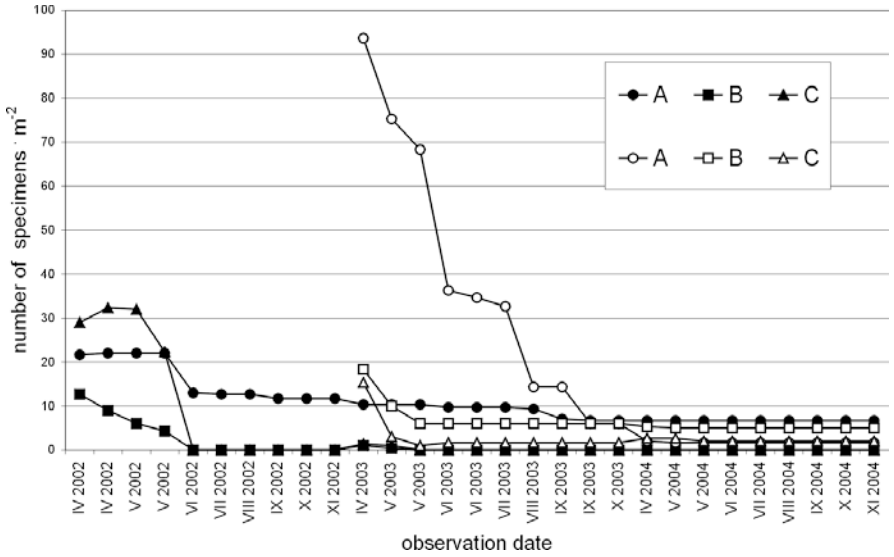

Fig. 1. Changes in the number of *Rumex confertus* Willd. genets in the area with vegetation cover removed (filled symbols: 2001 experiment, open symbols: 2002 experiment; A, B, C: coenopopulations).

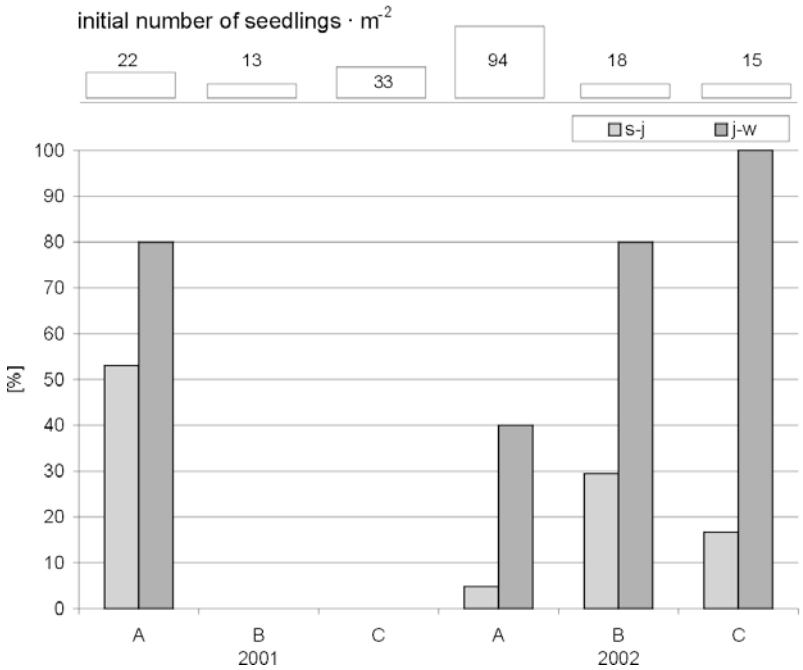

Fig. 2. Survival rate of *Rumex confertus* Willd. seedlings at early development stages in the area with vegetation cover removed (s j seedlings, j w juvenile specimens; A, B, C coeno populations).

Tab. 1

Changes of genet dispersion in different coenopopulations.

coenopopulations (experiment)	observation date	2002 V	2002 V	2002 V	2002 V	2002 V	2002 X	2002 X	2002 X	2003 V	2003 V	2003 V	2003 V	2003 V	2003 X	2003 X	2003 X
		Leksis' index															
	$A_{(2001)}$	0,72	0,77	0,43	0,36	0,36	0,35	0,35	0,35	0,31	0,31	0,25	0,25	0,26	0,28	0,29	0,29
	$A_{(2002)}$									5,00	4,94	3,36	1,49	0,94	0,94	0,19	0,17
	$B_{(2001)}$	0,89	0,33	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	$B_{(2002)}$									1,42	0,39	0,17	0,17	0,17	0,17	0,17	0,17
	$C_{(2001)}$	1,94	1,53	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	$C_{(2002)}$									1,14	0,13	0,13	0,13	0,13	0,13	0,13	0,10

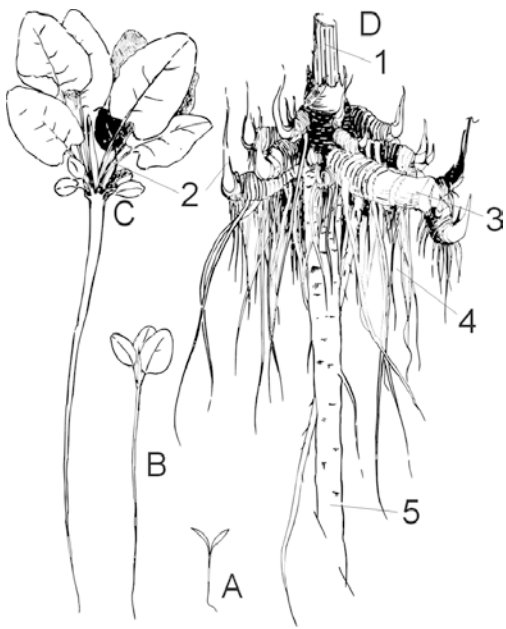

Fig. 3. Selected development stages of *Rumex confertus* Willd.: A – seedling, B – juvenile phase, C – virginile phase, D – generative phase (3 year genet), 1 – generative shoot, 2 – vegetative rosettes, 3 – rhizomes, 4 – adventitious roots, 5 – main root (orig.)

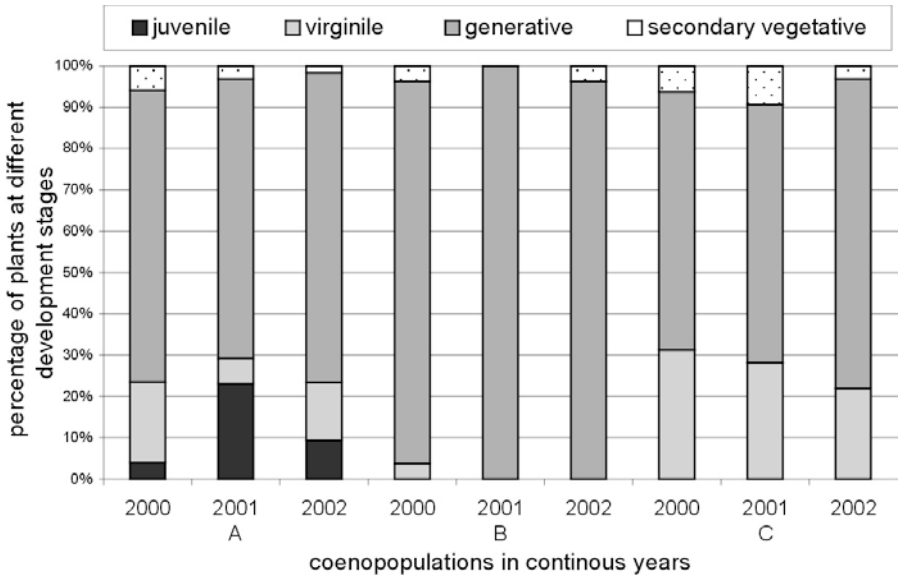

Fig. 4. The age state structure of *Rumex confertus* Willd. populations in permanent plots in subse quent years.

In the experiment set up in meadow in 2002 much more seeds germinated. However, because of a high death rate their number decreased during growing season by 80%, and only a few specimens per m^2 could be noticed after winter. Significantly less seeds germinated in areas within coenopopulations B and C, but these specimens, especially in their juvenile phase, were characterized by a higher survival rate (Figs. 1, 2).

Values of the Lexis index suggest especially in the year 2003 that seedlings are clustered in their distribution, which explains to some extent their high death rate (Tab. 1).

In the analyzed age-state structure in the middle of growing season no seedlings were observed, as they appeared very soon, before growing season. Nevertheless, development of a single individual of generative origin goes through five basic development stages: seedling, juvenile, virginile, generative and secondary vegetative phase (Fig. 3).

As it can be seen in Fig. 4, the meadow coenopopulation (A) has the most diversified age-state structure; all stages are present there. Genets in generative phase are the largest group, making about 70% of genets distinguished in a given sample plot. There are up to 30% of juvenile and virginile genets, and only 6% of secondary vegetative ones. The alike situation exists in coenopopulation C, where age-state structure is of similar proportions, with no juvenile phase though, as no seedling were found there during the study period. In the year 2000 in coenopopulation B only one

genet in virginile phase was found, other genets reached generative or secondary vegetative development stage. Because of low influx of new genets and longevity of mature plants, changes in the number of genets within three years are minimal.

DISCUSSION

Despite of high germination capacity under conditions close to optimal, seedlings of *Rumex confertus* do not appear often in nature (Jehlik et al. 2001; Ćwikliński, 1990). No doubts, genet clumps are formed by developing seedlings (Falińska, 1998). However, they appear only in a specific combination of habitat conditions (Ćwikliński, 1990).

The lack of so called safe germination sites, which are made by periodical disturbances, is reported as one of reasons for the situation (Falińska 1986, 2002; Pino et al., 1995; Löfgreen et al. 2000; Pino et al. 2002). Germination is often hindered by necromass accumulation causing soil intoxication (Miao et al. 1991; Pino et al. 1995). In turn, intensive meadow utilization enhances seed germination and stimulates further seedling development (Almazova and Rabotnov, 1953).

In natural conditions of Fordon Valley seedlings were found only in hay-growing meadow (coenopopulation A). This supports the view that remaining necromass may prevent the population from receiving new genets, while intensive disturbances help them to appear. Low and occasional influx of new genets into the population considerably simplifies its age structure. The meadow plots were the only areas with a significant participation of specimens in juvenile and virginile development stages, which together made 30% of all specimens in the population.

Since perennial genets prevail and individuals at early development stages have only minimal participation in *Rumex confertus* populations studied, one can suppose that life strategy of this species is characteristic of stable ecological systems and is mainly based on vegetative reproduction. Appearance of new individuals of generative origin depends on frequency and intensity of disturbances in phytocoenoses where the species is present.

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Efektywność reprodukcji generatywnej i struktura wiekowa populacji *Rumex confertus* Willd.

Streszczenie

Jednym z gatunków obcych, masowo wnikających do rodzimych zbiorowisk łąkowych i ruderalnych w dolinach większych rzek, jest *Rumex confertus*. Gatunek ten w ciągu stu lat opanował obszar niemal całej Polski. Liczne doniesienia o jego wysokim udziale w różnych fitocenozach kłócą się z informacjami o niewielkiej efektywności reprodukcji generatywnej.

W zbiorowiskach, w których gatunek ten najczęściej się spotyka kiełkowanie jest utrudnione z uwagi na brak bezpiecznych miejsc do kiełkowania. W takich warunkach liczebność populacji utrzymuje się dzięki pomnażaniu wegetatywnemu. Jedynie użytkowane rolniczo łąki wydają się sprzyjać dopływowi nowych genetów do populacji, co zapewne związane jest z niszczeniem zwartej darni i okresowym ograniczaniem konkurencji ze strony innych gatunków.