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KENOPHYTES AS RIVER CORRIDOR PLANTS IN THE VISTULA AND THE SAN RIVER VALLEYS

Marek Kucharczyk*, Rafał Krawczyk**

Katedra Geobotaniki
Uniwersytet Marii Curie-Skłodowskiej, ul. Akademicka 19, 20-033 Lublin
e-mail: *geobot@biotop.umcs.lublin.pl; **rkrawczy@biotop.umcs.lublin.pl

Summary. This paper is an attempt at analysing the distribution of kenophytes chorologically connected with two rivers in the valleys in SE Poland: the Vistula and the San. In the valleys there occur 25 kenophytes – river corridor plants. Most of them are of North American origin. Various species spread along particular parts of the profile of the valley, and the boundary between the various parts is marked by embankments that separate the part of the valley that is under the direct influence of the river and the historical terraces. The spread of kenophytes in river valleys is facilitated by the presence of permanently pioneer habitats in the immediate neighbourhood of the river channel.

Key words: kenophytes, river corridor plants, distribution pattern, vascular plants, the Vistula River, the San River, Poland

INTRODUCTION

In ecological research, rivers and their valleys are seen as elements connecting ecosystems, landscapes and routes of matter and energy transfer [Forman and Gordon 1986].

One of the aspects of the functioning of ecological corridors is the spread of both plant and animal species along rivers [Walters 1972, Naiman *et al.* 1993, Johansson *et al.* 1996, Walker and Smith 1997, Hood and Naiman 2000, Bij de Vaate *et al.* 2002]. For plant species chorologically connected with rivers the name „river corridor plants" is used [Burkart 2001]. A list of such river corridor plants in the Central European Lowland contains 129 plant species [Burkart 2001]. The list includes both species found on recent floodplains and those occurring in glacial valleys – on episodically flooded or non-flooded areas that can be treated as part of the river corridor on the basis of their geomorphological traits, including older terraces and valley slopes.

Apart from indigenous plants also kenophytes can have this type of distribution. These species often start to spread along watercourses and their settlement in river valleys is facilitated by the presence of permanently pioneer habitats [Kucharczyk 2003].

River valleys in Poland, and in particular in the eastern part of the country are characterised by a low degree of anthropogenic transformation; therefore, they lend themselves to research on chorological phenomena, including those that are connected with the formation of ranges of invasive species.

RESEARCH AREAS, MATERIAL AND METHOD

On the basis of the authors' own data and the data collected in the „Distribution Atlas of Vascular Plants in Poland" [Kucharczyk 2001, Zając and Zając 2001], the distribution of kenophytes spreading mainly along river valleys was analysed in the Middle Vistula River valley (from the mouth of the San to the mouth of the Wieprz River) and the Lower San River valley (from Ulanów to its mouth).

The flora was studied using the method of mapping all the species on a 1 km grid. These fields represent a decimal expansion of the grid of squares accepted in the "Distribution Atlas of Vascular Plants in Poland" – ATPOL [Zając 1978, Zając and Zając 2001].

The Vistula River is Poland's longest river – 1068.3 km for its full course between the source on the slopes of Barania Góra (Carpathian Mts) and the mouth on the Baltic coast. The Lublin region Vistula, between the mouths of the San (279.7 km) and the Wieprz Rivers (392.3 km of the course) is of a distinct gap character. It separates the Małopolska Upland and the Świętokrzyskie Mountains in the west and the Lublin Upland with Roztocze in the east. The distinctly different character of this part of the river valley has led to its being treated as a separate physical-geographic region – the Małopolska Vistula Gap [Kondracki 2001]. The width of the valley in this section ranges from 2 to 8 km.

The San River is the largest Carpathian tributary of the Vistula. Its full course is 444 km. In its lowland section the river flows through the belt of sub-mountain basins and joins the Vistula at the boundary of an upland area. In this section the river flows from the south east to the west north and is 125 km long and 7-17 km wide. The length of the river channel in this section is approx.160 km with a mean decline of 0.36‰. The river, regulated at the beginning of the 19th century, now flows in arcs with long radiuses.

RESULTS

Only 9 kenophytes of the 129 river corridor plants occurring in the big rivers valleys in Central Europe [Burkart 2001] have been noticed in the mentioned sections of the valleys. Furthermore, this river distribution pattern is also characteristic of 16 kenophytes (not included on the list). All of the 25 examined species are found in the Vistula valley and 16 in the San valley. The frequency of their occurrence in the Vistula valley is slightly higher than in the San valley, except for *Bidens frondosa,* which is more frequent in the latter.

Among river corridor kenophytes there are mainly newcomers from North America: *Aster lanceolatus*, *A. novae-angliae*, *A. novi-belgii*, *A. tradescanti*, *A. ×salignus*, *Bidens frondosa*, *Cuscuta campestris*, *Echinocystis lobata*, *Lemna turonifera*, *Oenothera*

salicifolia, *Rudbeckia laciniata* and *Xanthium albinum*. They occur mainly on floodplains and river terraces. The remaining ones come from South America (*Xanthium spinosum*), Southern Europe (*Eragrostis pilosa*, *Malva alcea*), Central and Western Europe (*Clematis vitalba*, *Diplotaxis tenuifolia*, *Brassica nigra*), Central Asia (*Impatiens glandulifera*), Eastern Europe and Western Asia (*Artemisia annua*, *Rumex confertus*, *Salix acutifolia*, *Salsola kali* subsp. *ruthenica*), Southern Asia and Northern Africa (*Portulaca oleracea*). *Oenothera hoelscheri* is an anthropogenic taxon. Species occurring in ruderal habitats are mainly kenophytes of Asiatic origin.

Table 1. List of kenophytes – river corridor plants occurring in the Lublin Region Vistula and Lower San rivers

Tabela 1. Kenofity chorologicznie związane z rzekami występujące w dolinie Wisły Lubelskiej i dolinie Sanu

List of kenophytes – Lista kenofitów	Geographical-historical status Grupa geograficzno-historyczna	Vistula River Wisła	San River San
Artemisia annua L.*	Ep	1	1
Aster lanceolatus Willd.	Ag	2	1
Aster novae-angliae L.	Ep	1	-
Aster novi-belgii L.	Ag	2	-
Aster tradescanti L.	Ep	1	-
Aster x *salignus* Willd.*	Ag	1	-
Bidens frondosa L.*	Ag	2	3
Brassica nigra (L.) W. D. J. Koch*	Ep	1	-
Clematis vitalba L.*	Ag	1	-
Cuscuta campestris Yunck.*	Ep	1	-
Diplotaxis tenuifolia (L.) DC.	Ep	1	1
Echinocystis lobata (F. Michx.) Torr. & A. Gray	Ag	3	3
Eragrostis pilosa (L.) P. Beauv.	Ag	3	2
Impatiens glandulifera Royle	Ag	2	2
Lemna turonifera Land.*	Ag	1	-
Malva alcea L.	Ag	2	1
Oenothera hoelscheri Renner em. Rostański	Ep	2	2
Oenothera salicifolia Desf. ex G. Don	Ag	2	1
Portulaca oleracea L. *subsp. oleracea**	Ep	1	1
Rudbeckia laciniata L.	Ag	2	1
Rumex confertus Willd.	Ag	3	3
Salix acutifolia Willd.	Ag	2	-
Salsola kali L. *subsp. ruthenica* (Iljin) Soó	Ep	2	1
Xanthium albinum (Widder) H. Scholtz*	Ag	3	3
Xanthium spinosum L.	Ep	2	1

Ag – agriophyte, Ep – epoecophyte, 1 – rare, 2 – dispersed, 3 – frequent, *Burkart's list [2001]
Ag – agriofit, Ep – epekofit, 1 – rzadki, 2 – rozproszony, 3 – częsty, *gatunek występujący na liście Burkarta [2001]

The percentage of species of various origin in the analysed valleys differs slightly from one to another: in the Vistula valley there are considerably more species of North American origin, while in the remaining groups of species the differences are much smaller (Fig. 1).

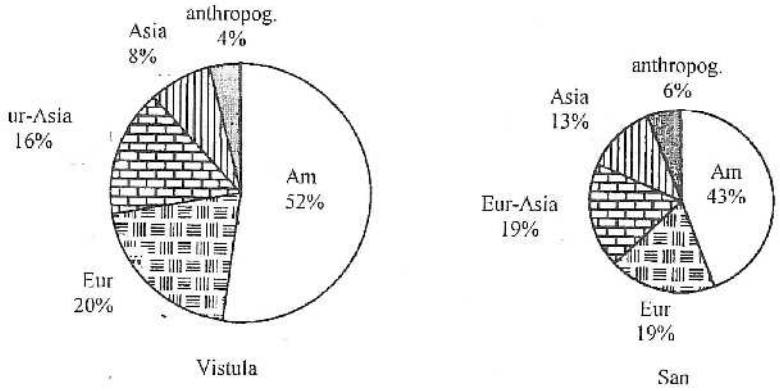

Fig. 1. Origin of kenophytes occurring in the Vistula and the San river valleys: Am – American, Eur – European, Eur-Asia – Eastern European-Western Asiatic, Asia – Asiatic, anthropog. – anthropogenic

Rys. 1. Pochodzenie kenofitów występujących w dolinach Wisły i Sanu: Am – północnoamerykańskie, Eur – europejskie, Eur-Asia – wschodniocuropejsko-zachodnioazjatyckie, Asia – azjatyckie, anthropog. – antropogeniczne

Depending on the type of habitat, the species can be divided into two main groups. The first one consists of agriophytes connected with habitats typical of river valleys: alluvia, riparian communities, old river beds and slopes. The other group includes mainly species found in ruderal habitats (epoecophytes).

Agriophytes occur in all parts of river valleys, both in the immediate neighborhood of the channel, and on terraces and slopes. There are distinctly more sites near the river channel. Such distribution pattern in valleys is typical of *Echinocystis lobata*, *Impatiens glandulifera*, *Malva alcea* and *Rudbeckia laciniata*. The remaining agriophytes are more closely connected with particular parts of the river valley, e.g. *Eragrostis pilosa* and *Xanthium albinum* occur in the immediate neighborhood of the river channel, while *Bidens frondosa*, *Lemna turonifera*, and *Rumex confertus* are found on river terraces separated by embankments.

The distribution pattern of epoecophytes is different: they are found both in ruderal habitats on the edges of river valleys (where towns and villages are situated) and very close to the river channel .

CONCLUSIONS

Among the 129 river corridor plants occurring in the big rivers valleys in Central Europe [Burkart 2001], 9 have been noticed in the mentioned sections of the valleys. Floristic analysis has shown that the river distribution pattern is also characteristic of 16 newcomers.

The river corridor plants are highly heterogenic and include groups that differ in their distribution in the valley.

In the Vistula and the San River valleys the areas with conditions typical of an active river are limited to the area between the embankments.

The active channel and floodplain are harsh environments for the establishment of plants. Nearly every year most riparian plants are subjected to floods, erosion, abrasion, drought, freezing, as well as anaerobic conditions. Limited competition from indigenous plants and open sites allow foreign species to settle here. In the Vistula River valley, the modern floodplain is characterized by high values of the anthropophytisation and modernisation indexes [Kucharczyk 2001b], which points to a high percentage of newcomers in the flora of this part of the valley. Among them, the river corridor distribution pattern is characteristic of *Eragrostis pilosa, Oenothera hoelscheri, Oe. salicifolia.*

Habitat conditions on historical floodplains (in the case of the above mentioned valleys these are river terraces separated from the river by its embankments) are considerably less harsh. Flooding occurs only when the water level is extremely high, as was the case in the years 1997 and 2001. A key factor in the spread of the species is the occurrence of both old and more recent oxbow lakes, terrace edges, as well as hillocks and meander scroll ridges. The ongoing deforestation of valleys and their extensive utilization also facilitate species expansion. In these parts of the valleys, the number of kenophytes is relatively low. After analyzing the whole river valley of the Vistula it can be observed that there are no anthropophytes that would spread along this part of the valley exclusively [Kucharczyk 2003].

The third group of species whose expansion is connected with river valleys includes species which occur on the peripheries of big river valleys, mainly in ruderal habitats in urban and rural settlements (*Xanthium spinosum, Diplotaxis tenuifolia*). Their distribution pattern is similar to that of species of xerothermic grasslands and scrub [Kucharczyk 2003].

Among river corridor kenophytes there are mainly newcomers from North America (12 species). They occur mainly on floodplains and river terraces. The remaining ones come from South America, Southern Europe, Central and Western Europe, Central Asia, Eastern Europe and Western Asia, Southern Asia and Northern Africa. Plants occurring in synanthropic habitats are mainly kenophytes of Asiatic origin.

The difference between the river valleys of the Vistula and San are very small. 9 species from those mentioned above have not been found in the Lower San River valley. The main reason for this the different layout of the valley, its smaller width and especially the smaller area of fresh alluvia.

The same degree of anthropogenic transformation in the valleys results in the spread of species of similar habitat requirements and similar geographic origin.

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KENOFITY JAKO GATUNKI ZWIĄZANE Z DOLINAMI RZECZNYMI W DOLINACH WISŁY I SANU

Streszczenie. W pracy analizowano rozmieszczenie kenofitów związanych chorologicznie z rzekami w dwóch dolinach południowo-wschodniej Polski: Wisły i Sanu. W dolinach występuje 25 tego typu kenofitów. Większość z nich pochodzi z Ameryki Północnej.
Gatunki te rozprzestrzeniają się w różnych częściach doliny; rozgraniczają je obwałowania, które oddzielają obszar pozostający pod bezpośrednim wpływem rzeki (międzywale) od jej historycznych terasów. Występowanie siedlisk stale pionierskich w dolinach dużych rzek sprzyja rozprzestrzenianiu się tej grupy kenofitów.

Słowa kluczowe: kenofity, gatunki związane z rzekami, wzorce rozmieszczenia, rośliny naczyniowe, Wisła, San