PLANT COVER OF THE SZUM RIVER VALLEY (ROZTOCZE, SOUTH-EAST POLAND)

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ABSTRACT

The break section of the Szum river and the mouth part of its left tributary, Miedzianka (Roztocze, SE Poland) were the object of the research conducted in the years 1999-2001. The aim of the study was to establish the abiotic conditions of the diversity of vegetation and the richness of vascular flora in a small lowland river valley. A real vegetation map was drawn in the scale 1:5000. The syntaxonomic classification of plant communities and habitat trophism were established on the basis of 120 phytosociological relevés and 160 soil samples, respectively. On the area of barely 35.4 ha identified were 48 plant associations and communities representing 11 phytosociological classes, among them habitats protected in Poland (16 types) and important at the EU scale (3). There were found 378 species of 72 families, including: 21 species under strict protection, 9 under partial protection, 25 plants threatened on the regional scale, and 2 included into the Polish Red Data Book. Most of interesting species and non-forest communities occur in the parts of the valley above and below a landscape reserve 'Szum', established in 1958, covering presently 18.17 ha. The greatest floral richness was found in the peatbog-meadow complexes (Phragmitetea, Molinio-Arrhenatheretea, Scheuchzerio-Caricetea), in bog-alder forests and willow bushes (Alnetea glutinosae), and streamline ash-alder carrs (Querco-Fagetea, Alno-Ulmion), while the smallest – in the pine and poorer upland mixed fir forests (Vaccinio-Piceetea). Vascular flora appears to be the richest in the sections of the valley where the bottom is overgrown by non-forest communities. The results of the study indicate that it is necessary to enlarge the area of the existing nature reserve.

KEY WORDS: small lowland river valley, plant communities, ecological conditions, vascular flora, protected and threatened species, nature conservation, geobotanical cartography.

INTRODUCTION

The complexity of the habitats and the active processes of plant succession in river valleys results in high productivity, biodiversity and a considerable abundance of the organisms of valley biotopes. Moreover, river valleys have been playing an important role as species migration routes, and as refugia of interesting, often relic flora and fauna (e.g. Piotrowska ed. 1982; Tomiałojć ed. 1993; Faliński 2000).

The habitat and vegetation arrangement is slightly different in the valleys of big and average rivers (rank I-II) and in the ones of small rivers and streams (rank III-IV), especially in their break sections. The former have been well described in literature on the subject. However, about the latter, relatively little information can be found (e.g. Buliński 1979; Piotrowska ed. 1982; Herbich, Górski 1993; Jutrzenka-Trzebiatowski, Dziedzic 1994; Bloch et al. 2000; Jutrzenka-Trzebiatowski et al. 2002). Yet, as a result of anthropopression, most of small river valleys have been already changed and only locally have managed to preserve their natural character (Tomiałojć ed. 1993). Therefore it is essential to make an inventory and provide protection, as soon as possible, of these small-area river fragments, often rich in unique natural and landscape values. These suggestions have been reflected in the European biodiversity protection programm, according to which wild, unregulated rivers and streams, described as the most valuable 'life corridors' and 'landscape aortas', yet often neglected by the researchers, are considered to be a protection priority (Parks for Life… 1994). River valleys are also key objects spinning into a web Europe's and Poland's protected areas (EECONET and ECONET-POLAND, respectively). An important part in this system is played by the Roztocze region within the borders of which there can be found almost all the regionally and internationally important elements of the ecological networks (Liro ed. 1998).

River valleys of Roztocze are an interesting and important element of vegetation landscapes, with their specific arrangement of habitats created as a result of ancient and present geological, geomorphological and hydrological processes. Many of these habitats were identified as CORI-

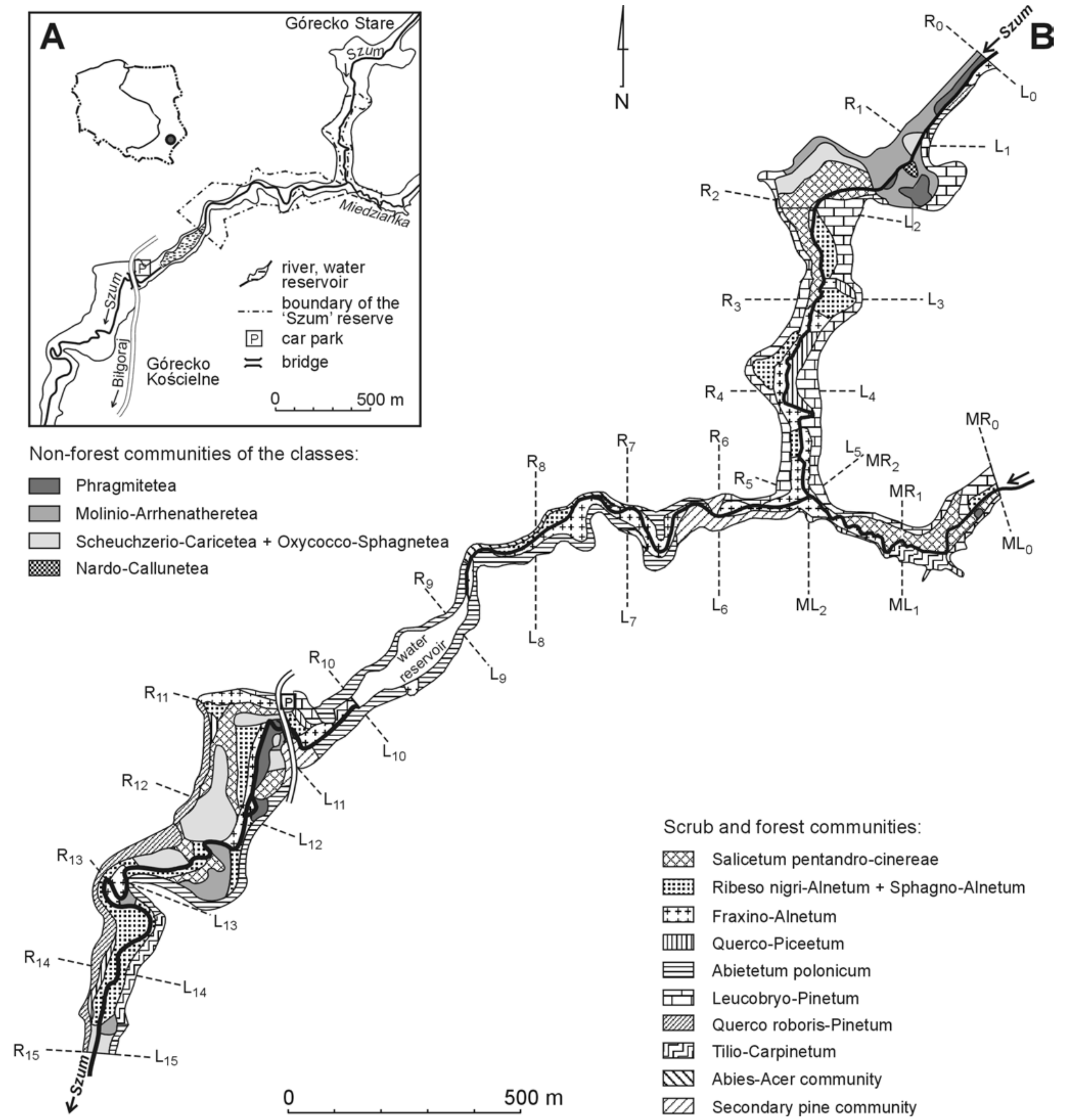

Fig. 1. Vegetation in the Szum river valley; A – situation of the study area; B – spatial distribution of main groups of plant communities; L, R – left and right bank sectors of the Szum river; ML, MR – left and right bank sectors of the Miedzianka river.

NE sites or biotopes of Europaen importance, and then recognized as potential elements of NATURA 2000 network (Dyduch-Falniowska, Zając 1996; Dyduch-Falniowska et al. 1999; Zając 2003).

MATERIAL AND METHODS

Study area

The Szum river valley, together with the mouth section of its left tributary, Miedzianka (Fig. 1A), both crossing the escarpment zone of Roztocze, were chosen as a model object of the study on plant cover diversity in a valley of a small, lowland river. The examined area lies in the mesoregion of Central Roztocze belonging to the Roztocze macroregion (Kondracki 2000). A characteristic climatic feature of the region is a considerable termic diversity visible in the monthly, seasonal and annual average air temperatures. The value of the mean annual temperature in the years 1951-1990 was 6.7-6.9°C, i.e. 0.3-0.8°C less than in the neighbouring areas, and this difference can be attributed to the influence of hypsometry (Kaszewski et al. 1995). On the other hand, the average precipitation is ca. 100 mm higher than the Polish mean, exceeding 700 mm, out of which 400-450 mm falls on the summer season (the data from the closest station in Tomaszów Lubelski: 50°27'N, 23°24'E; 270 m a.s.l.). The afforestation of this mesoregion reaches 50% (Czarnecka, Janiec 2002).

The Szum river (rank IV) is the last right tributary of the upper Tanew river, draining the south-western part of the mesoregion. It is a 24 km long stream with ca. 84 km^2 of the catchment area and flows verging from 401 to 616 l/s (Czarnecka, Janiec 2002). The most valuable part is the break section of the river stretching from the village of Górecko Stare to Górecko Kościelne (Fig. 1A). In 1958 a partial landscape reserve was established, covering 16.96 ha (presently 18.17 ha) of the Szum river break section (Fijałkowski 1974). Above and below the reserve, the valley has been considerably transformed, chiefly by deforestation of slopes. The break zone with the average slope of 8‰ is characteristic of diverse lithology, as there occur formations of various origin and age (Buraczyński 1997): upper Cretaceous gaizes and marls, Miocene lithotamnic limestones, lithotamnic-detritic marls and the formations of the Quaternary – Pleistocene (sands and clay sands) and Holocene (alluvial sands, sandy-clay deluvia and peats).

The diverse water-bearing of these formations results in the fact that in the valley there occur several levels of water mineralisation (differing by 9 times). Additionally, in the valley there exists a lateral water supply coming from the springs, effluences, gravitational flows and bog-springs. Below the mouth of the Miedzianka river the valley narrows considerably, sometimes up to 30 m only, and at places its bottom is reduced almost to the size of the river-bed. At this place, too, starts the 300 m long section of the rock faults and waterfalls (0.5-1.0 m tall), which for centuries have been called 'szum' ('hum') by the locals; hence the name of the river. Except for the break zone the valley reaches at places the width of 200 m (Czarnecka, Janiec 1999a, 2001, 2002).

According to projected ecological network NATURA 2000 for the Lublin Voivodship (Chmielewski et al. 2003), the study area lies within both types of protected sites: Special Protected Area (PLB 060012 'Roztocze') and Special Area of Conservation (PLH 060018 'Puszcza Solska'='Solska Primeval Forest').

Field study

The research done in the years 1999-2001 comprised a section of the main river valley, ca. 3 km between the villages of Górecko Stare and Górecko Kościelne, together with the 0.4 km mouth section of its left tributary, the Miedzianka river (Fig. 1). A real vegetation map was drawn in the scale 1:5000, including the most important forest and non-forest communities. Then, using a planimeter, the area of main communities (or ecological groups) was estimated. To facilitate the location of the communities on the map the study valley was divided into sections ca. 200 m long, separately for its left and right bank. In order to estimate the plant communities syntaxonomic affiliation 120 phytosociological relevés were taken, while the soil types were established on the basis of 33 soil pits. The habitat trophism was examined with the help of almost 160 soil samples, in which the following properties were marked: soil acidity, the content of organic matter, organic carbon, calcium carbonate and basic nutrients (Methods… 1967; Dobrzański et al. 1992). Additionally, the results of the physico-chemical analyses of soil and spring waters, particularly pH values and mineralisation (M), i.e. total content of minerals in mg/l, were used, too (Czarnecka, Janiec 1999a, 2002).

A detailed list of the valley's vascular flora was done, with particular attention turned to plant species that are rare in the Roztocze region, threatened on the regional (Kucharczyk 2000) and national scale (Kaźmierczakowa, Zarzycki eds 2001), and/or protected in Poland (Act… 2001). The floristic diversity was analysed with regard to its systematic families according to Rutkowski (1998), to the life forms according to Raunkiaer (1934, after Falińska 2004), and to the ecological groups of species (Matuszkiewicz 2001).

Nomenclature: vascular plants – Mirek et al. (2002), bryophytes – Ochyra et al. (2003), syntaxa – Matuszkiewicz (2001), soils – Trzciński ed. (1989).

RESULTS

The characteristics of the main groups of plant communities

On the basis of the phytosociological relevés and the geobotanical mapping, 48 associations and communities of 11 classes were distinguished (Table 1). Their spatial distribution (Fig. 1B) is conditioned by the following factors: topographic features, lithology, different water-bearing layers, water economy and soil types, and physico-chemical characteristics of waters and soils. Below discussed are the species variety and ecological conditions of plant communities that are very important because of their spatial participation, and because they are valuable and/or rare in the region, protected in Poland (16 habitats), and important in the EU scale (3 habitats).

Rush communities

Within *Phragmition* rushes three associations were distinguished: Sparganietum erecti, Equisetetum fluviatilis and Glycerietum maximae. The first community, connected with the river alluvium (Fig. 1B, sector L_2), is dominated by the characteristic species of *Sparganium erectum*. Yet, in its quite rich floristic composition (ca. 20 vascular plants species per patch) it groups other swamp and some meadow species, too. The community of Equisetetum fluviatilis (sectors L_2, ML_1), although richer in species than the previous one (30-40 vascular plant species per patch), is normally dominated by *Equisetum fluviatile* with addition of *E. palustre*, *Menyanthes trifoliata*, *Comarum palustre*, *Thelypteris palustris*, *Carex rostrata* and others. The phytocoenoses of this community occupy eutrophic habitats of the peaty-gley soils, usually supplied with slightly acid waters of the Cretaceous level (pH=6.4; M>300 mg/l). The Glycerietum maximae association dominated by reed sweet-grass occurs as a narrow belt of rushes in different sections of the river valley.

The Magnocaricion rushes occupy the habitats of various levels of hydration (sectors R_{1-2}, L_2, L_{12-13}): starting with highly hydrated ones, with the water level above the ground, and ending with overdried ones. The soils here belong to mesotrophic peat soils of low peat or peat-mud soils, ranging from slightly acid to alkaline ones (pH=5.4 in rhizosphere to 7.6 in deeper layers). The richest, as far as their floristic composition is concerned, are the rushes of Caricetum gracilis (sometimes almost 40 species in one phyto-

TABLE 1. The checklist of plant communities recognized in the Szum river valley, their status in EU and Polish conservation system. Communities ordered according to Matuszkiewicz (2001).

Association/Community	PHYSIS code[1]	NATURA 2000[2]	ACT 2001[3]
Urtico-Aegopodietum podagrariae (Tx. 1963 n.n.) em. Dierschke 1974	37.		
Alliario-Chaerophylletum temuli (Kreh 1935) Lohm. 1949	37.72		
Calystegio-Eupatorietum Gšrs 1974	37.7		
Calystegio-Epilobietum hirsuti Hilbig, Heinrich et Niemann 1972	37.7		
Com. Cardamine amara-Chrysosplenium alternifolium Oberd. 1977	54.112		+
Sparganietum erecti Roll 1938	53.143		
Equisetetum fluviatilis Steffen 1931	53.147		
Glycerietum maximae Hueck 1931	53.15		
Cicuto-Caricetum pseudocyperi Boer et Siss. in Boer 1942	53.218		+
Caricetum acutiformis Sauer 1937	53.2122		
Caricetum rostratae Rźbel 1912	53.2141		
Caricetum gracilis (Graebn. et Hueck 1931) R. Tx. 1937	53.2121		
Phalaridetum arundinaceae (Koch 1926 n.n.) Lib. 1931	53.16		
Glycerietum plicatae (Kulcz. 1928) Oberd. 1954	53.4		
Lolio-Polygonetum arenastri Br.-Bl. 1930 em. Lohm. 1975	87.2		
Prunello-Plantaginetum Faliński 1963	87.2		
Filipendulo-Geranietum W. Koch 1926	37.111		
Valeriano-Filipenduletum Siss. in Westh. et all. 1946	37.		
Lysimachio vulgaris-Filipenduletum Bal.-Tul. 1978	37.		
Lythro-Filipenduletum ulmariae Hadac et all. 1997	37.		
Filipendulo ulmariae-Menthetum longifoliae Zlinska 1989	37.242		
Angelico-Cirsietum oleracei R. Tx. 1937 em. Oberd. 1967	37.21	7230 m	+
Cirsietum rivularis Nowiński 1927	37.21A	7230 m	+
Scirpetum silvatici Ralski 1931	37.219		
Epilobio-Juncetum effusi Oberd. 1957	37.217		
Com. Poa pratensis-Festuca rubra Fijałk. 1962	38.		
Lolio-Cynosuretum R. Tx. 1937	38.111		
Caricetum limosae Br.-Bl. 1921	54.541	7150	+
Rhynchosporetum albae Koch 1926	54.61	7150	+
Caricetum lasiocarpae Koch 1926	54.51	7140	+
Carici canescentis-Agrostietum caninae R. Tx. 1937	54.4221		
Caricetum paniceo-lepidocarpae (Steffen 1931) W. Braun 1968[4]	54.2		+
Caricetum davallianae Dutoit 1924 em. Görs 1963	54.231	7210*	+
Sphagnetum magellanici (Malc. 1929) Kästner et Flössner	51.16	7110*	+
Com. with Nardus stricta / Nardetalia	35.1		+
Macroforb community of the order Origanetalia	34.4		
Salicetum pentandro-cinereae (Almq. 1922) Pass. 1961	44.921		+
Sphagno squarrosi-Alnetum Sol.-Górn. (1975) 1987	44.912		+
Ribeso nigri-Alnetum Sol.-Górn. (1975) 1987	44.9112		
Leucobryo-Pinetum W. Mat. (1962) 1973	42.52111		
Querco roboris-Pinetum (W. Mat. 1981) J. Mat. 1988	41.5811		
Abietetum polonicum (Dziub. 1928) Br.-Bl. et Vlieg. 1939	42.134	91P0 a	+
Pine community of the class Vaccinio-Piceetea	42.		
Querco-Piceetum (W. Mat. 1952) W. Mat. et Pol. 1955	42.C		
Fraxino-Alnetum W. Mat. 1952	44.341		+
Tilio cordatae-Carpinetum betuli Tracz. 1962	41.262	9170*m	+
Com. Abies alba-Acer pseudoplatanus	41.2		
Pine community of the class Querco-Fagetea	41.2		

Community codes and status:
[1] HABITATS DIRECTIVE… 1992; [2] INTERPRETATION MANUAL… 1999; [3] ROZPORZĄDZENIE… 2001; [4] Steffen 1931 (cit. after Brzeg, Wojterska 2001); * habitats of EU priority; m – Polish proposals accepted thanks to modification of EU habitats definitions; a – Polish proposal included into AMENDMENTS… 2002.

sociological relevé). The poorest species composition can be found in the rushes of Phalaridetum arundinaceae (only ca. 10 species per patch, with dominance of reed Canary-grass); it grows usually on very narrow belts of flooded mineral alluvia. In contrast, the association of Glycerietum plicatae (Spargano-Glycerion fluitantis) is usually limited to small patches mainly in the effluence zones and to outflows of more productive springs running to their recipient.

Generally, in Phragmitetea rush communities (2.5% of the study area) I noted 134 species of vascular plants, including such rare and protected ones as *Angelica archangelica* subsp. *litoralis*, *Dactylorhiza incarnata* subsp. *ochroleuca*, *D. maculata*, *Epipactis palustris* and *Menyanthes trifoliata* (Table 2).

Meadows

Meadows of the class Molinio-Arrhenatheretea (7.6% of the area) develop most commonly on the meso- and eutrophic peaty-gley and mud-gley soils, seasonally or permanently moist, and at places even wet. The biggest area is

TABLE 2. Rare, protected and threatened vascular plants in the Szum river valley.

Species	'Szum' reserve	Out of reserve	RL	PRDB
Anthericum ramosum	+			
Asplenium trichomanes	+		VU	
Cephalanthera damasonium (s)	+		VU	
Circaea intermedia	+		DD	
Dentaria glandulosa	+			
Equisetum hyemale	+			
Galium odoratum (p)	+			
Lilium martagon (s)	+			
Lycopodium clavatum (s)	+			
Scorzonera humilis	+			
Aruncus sylvestris (s)	+!	+		
Asarum europaeum (p)	+!	+		
Calla palustris	+	+		
Convallaria majalis (p)	+	+		
Dactylorhiza maculata (s)	+	+!	VU	
Daphne mezereum (s)	+	+		
Frangula alnus (p)	+!	+!		
Equisetum telmateia (s)	+	+!	CR	
Hedera helix (s)	+!	+		
Hepatica nobilis (p)	+!	+		
Huperzia selago (s)	+	+	VU	
Ledum palustre (p)	+	+		
Lycopodium annotinum (s)	+	+!		
Polypodium vulgare (s)	+	+		
Ribes alpinum	+	+		
Ribes nigrum (p)	+	+		
Viburnum opulus (p)	+	+		
Carex davalliana	+	+!	VU	
Dryopteris dilatata	+!	+	DD	
Angelica archangelica (s)		+		
Andromeda polifolia		+	LR	
Betula obscura		+	LR	
Carex appropinquata		+	DD	
Carex limosa		+	VU	LR
Dactylorhiza fuchsii (s)		+	CR	
Dactylorhiza majalis (s)		+!		
D. incarnata subsp. *ochroleuca* (s)		+	EN	EN
Drosera anglica (s)		+	EN	
Drosera intermedia (s)		+	EN	
Drosera rotundifolia (s)		+!	VU	
Dryopteris cristata		+	LR	
Epipactis helleborine (s)		+		
Epipactis palustris (s)		+!	VU	
Listera ovata (s)		+		
Menyanthes trifoliata (p)		+!		
Ophioglossum vulgatum		+	CR	
Petasites albus		+	EN	
Rhynchospora alba		+!	VU	
Scheuchzeria palustris		+	EN	
Sedum maximum		+		
Senecio rivularis		+	CR	
Thalictrum aquilegiifolium		+		
Utricularia minor		+	VU	
Utricularia vulgaris		+!		

Explanations:
LR – regional list (Kucharczyk 2000, supplemented), PRDB – Polish Red Data Book (Kaźmierczakowa, Zarzycki eds 2001). Categories of threat: EN – endangered, VU – vulnerable, LR – low risk, DD – data deficient. Categories of protection (ACT… 2001): s – under strict protection, p – under partial protection; ! – abundant occurence of species.

occupied by Filipendulion ulmariae meadows (sectors R_{1-2}, L_{13}), dominated by dicotyledonous perennials, which are usually the characteristic species of particular associations, e.g. *Filipendula ulmaria*, *Lysimachia vulgaris*, *Lythrum salicaria*, *Mentha longifolia*, *Geranium palustre*, *Veronica longifolia*, *Cirsium oleraceum*, *C. rivulare*, *C. palustre*, and others. Two types of eutrophic Calthion palustris wet meadows: Angelico-Cirsietum oleracei (formerly Cirsio-Polygonetum) and Cirsietum rivularis are included into list of EU habitats thanks to modification of definitions (Table 1). The macroforb meadows are sporadically mown, and most patches have not been mown for years, which facilitates the succession of alder and willow-alder bushes.

Apart from macroforb meadows we may also distinguish the rush-resembling patches of Scripetum silvatici. They grow over flat, wet land on the flood-plain bench (sectors L_{14-15}), and sometimes even on the meadow terrace (sector R_2). The peaty soils (pH=4.9-5.1) are supplied with acid and poor Quaternary gravitational flows (pH=5.5; M<100 mg/l). In contrast, the phytocoenoses of Epilobio-Juncetum effusi (sector L_2) grow over peaty soils supplied with highly mineralised Cretaceous waters (pH>6.0; M>300 mg/l).

The meadow communities are built of 108 vascular plant species. In this respect the richest ones are the communities of Poa pratensis-Festuca rubra and Cirsietum rivularis (usually over 40 species per phytosociological relevé), the poorest ones – the macroforb meadows clearly dominated by 1-2 species of perennial plants, e.g. Lythro-Filipenduletum ulmariae and Filipendulo ulmariae-Menthetum longifoliae (fewer than 20 species per patch). On the moist, at least sporadically mown meadows near Górecko Stare (sectors R_{1-2}) commonly occur the orchids *Dactylorhiza majalis* and *D. maculata*.

Peatbogs

Mossy-sedge peatbogs of the classes Scheuchzerio-Caricetea and Oxycocco-Sphagnetea occupy together 8.1% of the study area. In the mosaic of transitional and high moors, we may easily distinguish the relatively rare in the Roztocze region communities of Caricetum limosae (sector R_{12}) and Rhynchosporetum albae (sectors R_{12-13}), both listed as EU habitats (Table 1). The first one is connected with the peaty soil of transitory peat (pH=5.2-5.7), supplied with slightly acid water rich in mineral salts (pH=6.3; M>350 mg/l), including calcium ions whose presence is visible in the composition of the moss layer with such calciphilous species as *Scorpidium scorpioides*, *Drepanocladus revolvens*, *D. fluitans* and *Campyliadelphus stellatus*. The Rhynchosporetum albae association occurs in slightly less hydrated but more acid places (pH=4.1-5.2) than Caricetum limosae; it occupies a bigger area, too. Peat water is here very acid (pH=4.2) and very poorly mineralised (M= 80 mg/l).

A relatively big area is occupied by an acid bog-spring community Carici canescentis-Agrostietum caninae (sectors R_2, R_{12}), usually composed of *Agrostis canina* and several sedge species. The dried-up patches represent the subassociation of Carici-Agrostietum caninae caricetosum paniceae. In the edge-zone of transitional and high peatbogs, on peat or peat-mud soils, slightly acid (pH=5-6 in the rhizosphere) the phytocoenoses of Caricetum lasiocarpae are common (sectors R_2, R_{13}). Especially interesting in the Roztocze escarpment zone are the patches of Caricetum davallianae (one of EU habitats of priority importance) – a eutrophic bog-spring community abundantly supplied with mobile gravitational or spring flows rich in $CaCO_3$ (sectors R_2, L_{12}, L_{15}). It develops below the slopes in places slightly declining towards the flow, which guarantees the movement of the water in the peat layer. The peat soil of transitional moor shows alkaline, neutral or slightly acidic reaction (the latter only superficially). The moss layer has the admixture of the species suggesting the supply with highly mineralised waters, e.g. *Campyliadelphus stellatus* and *Drepanocladus aquaticus*. The other association of the same alliance Caricion davallianae – Caricetum paniceo-lepidocarpae – that develops on rather flat surfaces, represents also a type of wet eutrophic bog-spring community dominated by *Carex lepidocarpa*, with some calciphilous mosses, e.g. *Drepanocladus revolvens* and *Cratoneuron filicinum*.

Small patches of the next of EU priority habitat, the high peat-bog Sphagnetum magellanici (in sectors R_2, R_{13}, R_{15}), grow over oligotrophic, highly acid peat soils (pH=4.4-4.9) of considerable peat depth (up to 160 cm), founded on gleied loose or poor-clayey sands. They are supplied with poorly mineralised and extremely acid waters (M=50-80 mg/l; pH<4.0; 2.8 at the minimum!). Despite the fact that it occupies the places positioned higher than the transitional moors, and that its hillock-small valley structure is better developed, it nevertheless does not possess any specific species composition apart from the higher participation of evergreen dwarf shrubs of *Andromeda polifolia* and *Oxycoccus palustris*, and of *Polytrichum strictum*.

Vegetation of transitional and high peatbogs are characteristic of considerable richness of species, both of vascular plants (together 142 species), and of bryophytes (ca. 40 taxa). Particular phytocoenoses, however, are built with different numbers of species: starting with 20 (the most highly hydrated patches of Caricetum lasiocarpae or Rhynchosporetum albae), reaching 40 or more (some of the patches of Caricetum davallianae and Carici canescentis-Agrostietum caninae). Moreover, they serve as refugia for numerous rare or threatened as well as protected species: *Carex limosa*, *Drosera anglica*, *D. intermedia*, *D. rotundifolia*, *Utricularia vulgaris*, *U. minor*, *Scheuchzeria palustris*, *Epipactis palustris*, *Dactylorhiza fuchsii*, *D. maculata* and *D. majalis* (Table 2).

Other non-forest communities

Despite the relatively small area, it is worth to notice some spring communities (Montio-Cardaminetea) accompanying numerous springs and effluences, including the ferruginous ones. Altogether, in the study section of the river 41 effluences were found, mostly of the spring yield reaching several l/s. Three springs exhibit a higher iron content (up to 1.36 mg Fe^{++}/l), which is manifested in the impressive deposits of ferric orcha. Spring vegetation, connected with the well-oxygenated water of slightly acidic or neutral reaction (pH=6.4-7.5), is distinguished due to its peculiar species combination. Among the vascular plants the most constant are *Cardamine amara*, *Chrysosplenium alternifolium* and *Glyceria plicata*, and the other coming from ash-alder carrs and bog-alder forests. Numerous, too, are mosses (mainly *Plagiomnium undulatum* and *Brachythecium* spp.) and liverworts (especially *Pellia* spp. and *Aneura* spp.).

The remaining non-forest phytocoenoses are represented by so-called carpet communities (Plantaginetalia majoris) developing in heavily trodden and/or grazed places (e.g. Lolio-Polygonetum arenastri and Prunello-Plantaginetum). The next ones are macroforb communities of two orders of the Artemisietea vulgaris class: Glechometalia hederaceae (Urtico-Aegopodietum podagrariae, Alliario-Chaerophylletum temuli) and Convolvuletalia sepium (Calystegio-Eupatorietum, Calystegio-Epilobietum hirsuti), as well as the order Origanetalia (Trifolio-Geranietea) accompanying edges of forest communities. The first ones occur in relatively wet, meso- and eutrophic habitats in the valley bottom (along the stream) and the latter on dry, rather steep slopes, particularly in ecotones or good-lit openings within mixed oak-pine forest.

Scrub and forest communities

The valley bottom is covered by bog-alder forests (12.5% of the study area) and shrubs (12%) of the class Alnetea glutinosae. Forests belong to two associations, with the clear dominance of Ribeso nigri-Alnetum, best developed in the sections above and below the strict break zone (Fig. 1B; sectors R_{2-3}, R_{11-12}, L_2, L_{13}, MR_1, MR_2). Bog scrubs and forests are connected with peat, sometimes with mud-peat, or even with mud soils. They are supplied with the Quaternary waters, rather poorly mineralised (M<100 mg/l). Mineral habitats on the flood-plain bench are taken by Alno-Ulmion forests. Some of the streamline ash-alder forest Fraxino-Alnetum (12.6% of total study area) have spring character, such as the patches with the dominating Athyrium filix-femina (sector L_8), supplied with the Tertiary springs and effluences (pH=6.3; M>300 mg/l)) or such as the carr with *Equisetum telmateia* (sector L_9), supplied with carbonate waters of the Cretaceous level (pH=6.5-7.0; M=250-300 mg/l).

Phytosociologically and ecologically diverse communities in the bottom of the valley are definitely rich in species. The following numbers of vascular plant species were noted here: Salicetum pentandro-cinereae – 128; Ribeso nigri-Alnetum – 138; Sphagno squarrosi-Alnetum – 38 (because of small area occupied by this community); Fraxino-Alnetum – 131. I found here several species rare, protected, or even threatened in the Roztocze region, e.g. *Aruncus sylvestris*, *Dactylorhiza fuchsii*, *D. maculata*, *Daphne mezereum*, *Dryopteris cristata*, *Epipactis helleborine*, *E. palustris*, *Equisetum telmateia*, *Hedera helix*, *Huperzia selago*, *Ophioglossum vulgatum*, *Petasites albus*, *Ribes nigrum*, *Senecio rivularis* and *Thalictrum aquilegiifolium* (Table 2).

The valley's slopes, covered with the soils subjected to the process of podzolization, are overgrown with forests of the class Vaccinio-Piceetea, with the most common suboceanic pine forest Leucobryo-Pinetum (16% of the area) and mixed oak-pine forest Querco roboris-Pinetum (4.8%). The steepest slopes, mostly located within the borders of the reserve and near the water basin, are overgrown with upland mixed fir forest Abietetum polonicum (13.2%), which can be divided into two subassociatios: A. p. circaeetosum on the fertile leached brown soils and leached brown rendzinas and A. p. typicum on poorer and drier proper podzol soils.

Forest communities of the class Querco-Fagetea occupy the north-western slope exposure with sandy soils and are represented by fragments of the linden-hornbeam forest Tilio cordatae-Carpinetum betuli (3.3% of total area) and by small patches of the sycomore mapple-linden-fir forest which are preliminary described as the community of Abies alba-Acer pseudoplatanus (sectors R_{8-9}). The latter is

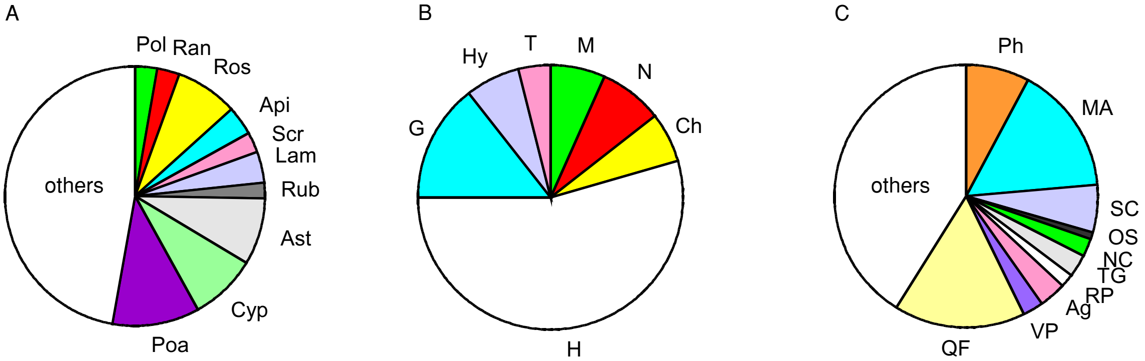

Fig. 2. Diversity of the vascular flora in the Szum river valley; A – systematic spectrum (families and numbers of species): Pol – *Polypodiaceae* (11), Ran – *Ranunculaceae* (10), Ros – *Rosaceae* (29), Api – *Apiaceae* (14), Scr – *Scrophulariaceae* (9), Lam – *Lamiaceae* (15), Rub – *Rubiaceae* (8), Ast – *Asteraceae* (31), Cyp – *Cyperaceae* (32), Poa – *Poaceae* (41); B – biological spectrum (life forms, in %): M – megaphanerophytes (7%), N – nanophanerophytes (8%), Ch – chamaephytes (6%), H – hemicryptophytes (54%), G – geophytes (15%), Hy – hydrophytes (6%), T – terophytes (4%); C – ecological spectrum (characteristic species of different classes, in %): Ph – *Phragmitetea* (7.7%), MA – *Molinio-Arrhenatheretea* (15.9%), SC – *Scheuchzerio-Caricetea* (5.8%), OS – *Oxycocco-Sphagnetea* (0.8%), NC – *Nardo-Callunetea* (2.4%), TG – *Trifolio-Geranietea* (2.6%), RP – *Rhamno-Prunetea* (1.8%), Ag – *Alnetea glutinosae* (3.2%), VP – *Vaccinio-Piceetea* (2.6%), QF – *Querco-Fagetea* (16.1%).

characteristic of loose fir stand and high participation of *Acer pseudoplatanus* and *Tilia cordata*. The substratum, leached brown soil and proper rendzina, is rich in $CaCO_3$ facilitating the presence of termophilous plant elements.

Altogether in the forest communities of the valley slopes the following numbers of vascular plant species were observed: Leucobryo-Pinetum – 64; Abietetum polonicum – 75; Querco roboris-Pinetum – 76; Tilio-Carpinetum – 51; the community of Abies alba-Acer pseudoplatanus – 81. They include such rare and protected species as *Asplenium trichomanes*, *Cephalanthera damasonium*, *Equisetum hyemale*, *Lilium martagon*, *Lycopodium annotinum*, *L. clavatum*, *Polypodium vulgare*, *Ribes alpinum* and *Sedum maximum* (Table 2).

Vascular flora

In the examined area of the Szum river valley of barely 35.4 ha, I noticed 378 species of vascular plants, representing 72 systematic families. Representatives of the most numerous 10 families make almost 53% of the total number of vascular plants (Fig. 2A). The most numerous in species is the genus *Carex* – 27; this abundance is connected with a considerable participation and diversity of rushes, meadows and peatbogs (Fig. 1B). The following genera, as far as their number is concerned *Rubus*, *Galium*, *Salix*, *Equisetum*, *Rumex*, are represented by 6-8 species only. Vascular flora appears to be the richest in the sections where in the valley bottom there occur non-forest communities.

In the biological spectrum of vascular plants hemicryptophytes are the dominant group of herb species (Fig. 2B). The abundance of the dendroflora (mega- and nanophanerophytes; 56 species together) points to the role of the transitional zones between forests and peatbog-meadow complexes, where there occur intense succession processes.

The most numerous ecological groups are created by plants of temperate forests (Querco-Fagetea) and meadows (Molinio-Arrhenatheretea; Fig. 2C). The species of the first class are especially abundant within the boundaries of the nature reserve – up to 40-50%. A greater share of meadow species, as well as the species of the classes Phragmitetea and Scheuchzerio-Caricetea, can be observed in these parts where the valley floor is overgrown with rushes, meadows, peatbogs, and alder-willow bushes – up to 20-40% altogether (e.g. sectors R_{2-3}, R_{12-15}). The species of the next 6 classes: Nardo-Callunetea, Trifolio-Geranietea, Alnetea glutinosae, Vaccinio-Piceetea, Oxycocco-Sphagnetea and Rhamno-Prunetea, are a rather small fraction of the flora. Sporadically, there appear also representatives of the classes of Artemisietea vulgaris, Bidentetea tripartiti, Chenopodietea, Epilobietea angustifolii and others.

It is worth emphasising that in relatively small area many valuable species were found, including mountain elements. Among them there are: 21 species under strict protection, 9 under partial protection, 25 plants threatened at the regional scale, and 2 included into the Polish Red Data Book. Most of them occur in the parts of the valley above and below the nature reserve (Table 2).

DISCUSSION

The Szum river valley differs favourably from the other valleys of the upper Tanew river tributaries (Niepryszka, Sopot, Jeleń and the Łosiniecki Stream), precisely due to its rich and diverse vegetation and flora of meadow-peatbog complexes. Its hydrochemical and trophic diversity, its richness of species and presence of valuable elements – they all may be said to even exceed in value similar ecosystems of the Roztocze National Park (Izdebski et al. 1992). This fact implies the necessity of protection which would prevent the advancing succession of alder and willow-buckthorn shrubs, and the creation of small-retention basins on private lands (Czarnecka 2003). Both the overgrowing of naturally woodless peatbog areas, and anthropopression can result in the irretrievable loss of natural values of this valley fragment. Worthy of emphasising is the fact that in the escarpment zone of the Roztocze region, due to its lithology, there exist very few moor areas, out of which only 3.8 ha of peatbogs are protected in the 'Nowiny' partial reserve (Borchulski et al. 1987).

The arrangement of the forest communities of the Szum river valley is not radically different from the arrangements found in other valleys of the escarpment zone. It is, however, unique due to the presence of the linden-hornbeam forest, and well-lit fragments of the mapple-linden-fir forest with termophilous species, and phytocoenoses of Sphagno squarrosi-Alnetum, which occur only here and in the Jeleń river valley. On the other hand, in the studied valley there are no ash-alder carrs on peat soil of suspended low peats which developed in the river valleys of Jeleń and Sopot (Fijałkowski 1974; Fijałkowski, Łuczycka-Popiel 1989; Izdebski et al. 1992; Janiec, Czarnecka 1998, 2001; Czarnecka, Janiec 1999a, b, c, 2000; Czarnecka et al. 2001; Czarnecka, unpubl. data).

The most valuable community of the valley's steep slopes, the fir forest Abietetum polonicum, is connected with quite specific fresh and moist habitats. The main tree species of this community, *Abies alba*, appears here closely to its north-eastern border of its geographical range. This fact was one of the arguments in favour of placing the fir forests of the escarpment zone under protection and in 1958 three reserves were created: 'Szum' ('Hum'), 'Czartowe Pole' ('Devil's Field') and 'Nad Tanwią' ('On the Tanew River'). The association Abietetum polonicum in the Szum river valley shows a considerable floristic and habitat similarity to the patches of this community described in other parts of the Central Roztocze region (Fijałkowski 1974; Fijałkowski, Łuczycka-Popiel 1989; Izdebski et al. 1992). The Holy Cross fir forest Abietetum polonicum is one of three Polish proposals of priority importance habitats accepted by European Topic Centre on Nature Conservation (cf. Table 1). It is worthy of mentioning that in this area the fir is in a relatively better condition than in the Świętokrzyskie (Holy Cross) Mountains or in the Cracow-Częstochowa Upland.

The floristic richness of the examined river valley confirms the observations made about the break sections of other small lowland rivers, e.g. in the young glacial landscape of northern Poland. Processes of seasonal flooding, lateral erosion and backward spring erosion which contribute to the higher biogenic abundance of young soils exposed in the landslide headwalls, the habitat mosaic of the river bottoms, together with the simultaneous presence of various stages of vegetation succession – all these factors foster diversity and species richness of plant communities (Herbich, Górski 1993; Faliński 2000). For example in the Kaszuby Lake district, in the break zone of the Reknica river, 619 vascular plant species were observed (Buliński 1979); in the Radunia break – 537 species (Piotrowska ed. 1982); in the ravine of the Brynica river (the Dobrzyń Lake district) – 417 species (Jutrzenka-Trzebiatowski, Dziedzic 1996) – all of them in the area smaller than 100 ha. During the geobotanical research done during the past few years in the break zones of five rivers: Szum, Niepryszka, Sopot, Jeleń and the Łosiniecki Stream, 470 species altogether were found (Czarnecka, Janiec 2002).

The case of the studied river valley proves that the richness of flora and vegetation is the greater, the more diverse are the abiotic conditions (relief, rock substratum, soil type, water economy characteristics, the level of water mineralisation, habitat trophism). The carried out research shows also that small lowland river valleys fully deserve environmental protection not only because of their landscape values, but primarily because of their role of the refugia for various taxonomic and ecological groups of plant, including the rare, protected and threatened elements (Buliński 1979; Piotrowska ed. 1982; Jutrzenka-Trzebiatowski, Dziedzic 1994; Bloch et al. 2000; Jutrzenka-Trzebiatowski et al. 2002, and others).

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