



NEW LOCALITY OF *GENTIANA CRUCIATA* L. IN THE STRZYŻÓWSKIE FOOTHILLS (WESTERN CARPATHIANS)

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ABSTRACT. In 2006, ca. 60 individuals of *Gentiana cruciata* were found in the Strzyżowskie Foothills. Until recently, only one locality of the species in the area has been reported from Kołaczyce in the Wisłoka River valley by Knapp in the 19th century. The new locality is situated in the Wielopolka River valley on an S-SW-W slope with varied inclination. In total, 16 phytosociological relevés were taken with the use of the Braun-Blanquet method in patches comprising *Gentiana cruciata*. The patches were characterised by high proportions of species from the classes *Molinio-Arrhenathereta*, *Festuco-Brometea*, and *Trifolio-Geranieta*. Given the dominance of meadow species, the community was classified as a thermophilic fresh meadow from the alliance *Arrhenatherion*. An upward trend was noted in the analysed population, as the number of the individuals increased to ca. 160 in 2014.

KEY WORDS: *Gentiana cruciata*, endangered species, xerothermic grasslands, Wielopolka River valley, Strzyżowskie Foothills

INTRODUCTION

Gentiana cruciata L. has a Euro-Siberian occurrence range, covering southern and central Europe, Asia Minor, the Caucasus, Turkestan, and western Siberia (MEUSEL et al. 1978, HULTÉN & FRIES 1986, ZAJĄC & ZAJĄC 2009). In Poland, the localities of this species are concentrated in the mountains and along the upland belt in the south of the country. The species also occurs in the lower Oder and Vistula regions, the Mazury Lake District, as well as in Pomerania and Wielkopolska. Its most frequent occurrence has been noted in the Eastern Carpathians, the Lublin Upland, and in the Sudeten Mountains. It has not been reported from central Poland (ZAJĄC & ZAJĄC 2001). In the mountains, the species reaches the lower forest zone. The highest locality was reported from Wysokie Skałki in the Małe Pieniny Mountains (950 m a.s.l.) (PIĘKOŚ-MIRKOWA & MIREK 2003).

Gentiana cruciata belongs to the family *Gentiana-ceae*. It is a perennial species characterised by a thick rhizome and a height ranging from 10 to 40(60) cm.

It has an erect or rising, densely foliated stem with internodes that are considerably shorter than the leaves. The basal leaves, usually 5–8, are obovate-lanceolate in shape. The light-green stem leaves are fused into a sheath and exhibit decussate arrangement. They are lanceolate-obovate or lanceolate in shape and 10 cm long and 2 cm wide. The flowers are arranged in a capitulum at the stem apex; additionally, 1–3 sessile, tetramerous flowers cluster in the upper leaf axils. The 2–3 cm long corolla is tubular-campanulate in shape, tetragonal, dirty-blue in colour, with triangular, outwardly curved lobes. The fruit is a 2 cm elongated capsule with wingless seeds. The species flowers between June and August (JASIEWICZ 1971, PIĘKOŚ-MIRKOWA and MIREK 2003, 2006).

Gentiana cruciata is a hemicryptophyte with considerable light and thermal requirements (ZARZYCKI et al. 2002). It grows on dry meadows, grasslands, pastures, steep and warm slopes, in light scrubs, at forest edges, and along roadsides. It prefers clay or loess soils containing calcium carbonate with neutral or alkaline reaction (pH 6,6–8,4). It occurs on

carbonate rendzinas and pararendzinas, and less frequently on brown earth and chernozems proper (PIĘKOŚ-MIRKOWA & MIREK 2003, 2006).

Gentiana cruciata is a characteristic species for the class *Festuco-Brometea* and, regionally, for the association *Adonio-Brachypodietum pinnati* (MATUSZKIEWICZ 2001). In the Małopolska Upland, it was noted in *Sisymbrio-Stipetum capillatae* patches (KOSTUCH & MISZTAŁ 2007). It also grows in thermophilic meadow communities, e.g. on xerothermic *Anthyllidi-Trifolietum montani* meadows in the Pieniny Mountains (KAŹMIERCZAKOWA et al. 2004), in a thermophilic fresh meadow sub-association *Arrhenatheretum elatioris brizetosum mediae* in the Przemyskie Foothills (BARABASZ-KRASNY 2011), and in a mesophilic sub-association *Adonio-Brachypodietum pinnati arrhenatheretosum* and a community *Centaurea scabiosa-Agrimonia eupatoria* in the Silesian Upland (BABCZYŃSKA-SENDEK 2005).

In Poland, *Gentiana cruciata* is under strict species protection (ROZPORZĄDZENIE... 2014). Moreover, it has been included in many regional red lists and assigned category CR in the Opole Voivodeship and Wielkopolska (BABCZYŃSKA-SENDEK & NOWAK 2002, JACKOWIAK et al. 2007, NOWAK et al. 2008); EN: in Gdańsk Pomerania and Western Pomerania (ŻUKOWSKI & JACKOWIAK 1995, MARKOWSKI & BULIŃSKI 2004); VU: in the Sudeten and the entire Lower Silesia, Silesian Province, Małopolska Upland, Roztocze, Western Polesie, Kuyavian-Pomeranian Province, Południowopodlaska Lowland, and Łódź Province (KUCHARCZYK & WÓJCIK 1995, RUTKOWSKI 1997, BERNACKI et al. 2000, FABISZEWSKI & KWIATKOWSKI 2002, GŁOWACKI et al. 2003, KAĆKI et al. 2003, BRÓŹ & PRZEMYSKI 2009, KURZAC & OLACZEK 2012, PARUSEL & URBISZ 2012). In the Świętokrzyskie Province and the northern part of the Silesian-Cracow Upland, the species has a status of a rare plant with category R (BRÓŹ 1990, HEREŹNIAK 2002).

MATERIAL AND METHODS

The investigations were conducted in two periods: 2006–2007 and 2012–2014. Sixteen phytosociological relevés were taken using the Braun-Blanquet method (PAWŁOWSKI 1977), i.e. two in 2006–2007 and 14 in 2012–2013. The relevés are presented in a synthetic table (Table 1). Phytosociological stability and the coverage index were calculated. The species names follow a critical list of Polish vascular plants (MIREK et al. 2002) and the syntaxonomic affiliation was determined according to the system proposed by MATUSZKIEWICZ (2001).

DESCRIPTION OF THE LOCALITY

The newly discovered locality is situated in Nawsie at the border with Wielopole Skrzyńskie in the Podkarpackie Voivodeship. The area is located in

the Strzyżowskie Foothills, which belongs to the Outer Western Carpathians (KONDRACKI 2012). Until recently, *Gentiana cruciata* has been reported in the Strzyżowskie Foothills only in Kołaczyce in the Wisłoka River valley (KNAPP 1869, TOWPASZ 1987), and this locality still exists. In Nawsie, the species grows on the slope of an alluvial fan characterised by varied exposure and inclination. The fan is intersected by a 2 m deep holweg formed through erosion of a field path. It divides the locality into two parts. The part located below the holweg (S exposure) is currently a fallow that is becoming overgrown by *Prunus spinosa*. It is irregularly grazed or mowed only at its foot. The other part of the slope located above the holweg (SW–W exposure) is regularly grazed. An additional terrain form is an earth excavation pit formed in the lower part of the slope.

The analysed species was first noted in this area in 2006 and its occurrence was documented with a phytosociological relevé. The observation was repeated the following year. Detailed investigations were carried out in 2012–2014, when 14 phytosociological relevés, each with an area of 25 m², were taken (Table 1). The relevés showed 23 to 41 species (31 on average). In the first period of the research, 60 *Gentiana cruciata* individuals were noted (50 below the holweg and 10 in the upper part of the slope). In the other period, 160 individuals were observed. A substantial increase in their number was noted on the grazed slope above the field path (95), while there were 65 individuals below the holweg. From two to seven shoots (on average four) were found in the scrubs. The community with *Gentiana cruciata* has a thermophilic nature and its species composition resembles that of fresh meadows, xerothermic grasslands, and thermophilic fringes. The patches comprised seven species from each of the *Festuco-Brometea* and *Trifolio-Geranietea* classes. Some of them are rare in the flora of the Strzyżowskie Foothills (*Centaurea scabiosa*) or they have been noted in only one locality in this part of the Carpathians (*Brachypodium pinnatum*, *Scabiosa ochroleuca*, *Gentiana cruciata*). All the relevés showed dominance of meadow species from the alliance *Arrhenatherion* (e.g. *Arrhenatherum elatius*, *Galium mollugo*), order *Arrhenatheretalia* (e.g. *Achillea millefolium*, *Daucus carota*), and class *Molinio-Arrhenatheretea* (e.g. *Vicia cracca*, *Planatago lanceolata*, *Leontodon hispidus*). *Crataegus monogyna*, *Prunus spinosa*, *Rosa canina*, *Cornus sanguinea* shrubs were noted in the uncultivated part of the slope. Their abundance evidences progressive succession towards scrubs from the class *Rhamno-Prunetea*. Additionally, species typical of ruderal habitats (e.g. *Cichorium intybus*, *Cirsium vulgare*, *Melilotus officinalis*), which encroached from the adjacent fallows and post-agricultural land, were found. The community with *Gentiana cruciata* was accompanied by species that do not belong to any syntaxonomic unit.

Table 1. Occurrence of *Gentiana cruciata* in thermophilic meadow communities from the alliance *Arrhenatherion*

Successive number of relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Constancy	Cover coefficient	
	day	3	18	7	7	7	7	7	7	7	12	12	12	12	12	12			12
	month	7	6	7	7	7	7	7	7	7	7	7	7	7	7	7			7
	year	2006	2007	2012	2012	2012	2012	2012	2012	2012	2013	2013	2013	2013	2013	2013			2013
Aspect	SW	SW	SW	W	SW	SW	SW	S	S	S	S	S	S	S	S	S			
Inclination [°]	30	30	20	30	30	30	35	45	10	40	40	40	40	5	10	35			
Altitude [m a.s.l.]	268	268	275	267	279	278	284	258	258	261	261	261	261	267	267	266			
Cover of herb layer [%]	90	90	100	95	100	100	100	100	100	100	100	100	100	100	100	100			
Cover of shrub layer [%]	-	-	-	-	-	-	-	-	15	-	-	-	-	10	5	-			
Management*	g	g	g	g	g	g	g	g	-	m/g	m/g	m/g	m/g	-	-	m/g			
Area of relevé [m ²]	100	100	25	25	25	25	25	25	25	25	25	25	25	25	25	25			
Number of species	26	32	41	35	23	28	26	29	27	40	38	32	33	25	30	32			
<i>Gentiana cruciata</i>	1.2	1.2	1.2	+	+	1.2	1.2	r	2.2	+	+	r	r	1.2	+	+	V	325	
ChAll. <i>Arrhenatherion</i>																			
<i>Arrhenatherum elatius</i>	2.2	2.2	3.2	+	.	2.2	3.2	5.5	3.3	3.2	2.2	2.2	3.2	2.2	2.2	1.2	V	2519	
<i>Galium mollugo</i>	.	1.2	1.2	+	+	+	+	+	1.2	2.2	1.2	+	+	1.2	2.2	.	V	397	
<i>Knautia arvensis</i>	.	+	+	+	.	+	1.1	1.1	+	+	+	.	+	+	+	+	V	97	
<i>Crepis biennis</i>	+	1.2	1.2	1.2	+	.	.	+	.	+	+	+	+	.	.	+	IV	119	
ChO. <i>Arrhenatheretalia elatioris</i>																			
<i>Achillea millefolium</i>	2.2	1.1	1.1	2.2	4.3	1.2	+	1.1	+	+	+	+	1.1	+	1.2	1.2	V	847	
<i>Daucus carota</i>	+	.	+	2.2	1.2	+	+	1.1	.	+	+	+	1.1	+	+	1.1	V	263	
<i>Dactylis glomerata</i>	+	1.2	+	.	.	+	+	+	+	+	+	+	+	+	+	+	V	72	
<i>Lotus corniculatus</i>	.	+	+	+	.	+	+	.	+	+	+	+	.	.	.	+	IV	31	
<i>Trifolium repens</i>	.	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	II	13
<i>Bellis perennis</i>	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	3
<i>Cynosurus cristatus</i>	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	3
<i>Heracleum sphondylium</i>	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I	3
ChCl. <i>Molinio-Arrhenatheretea</i>																			
<i>Vicia cracca</i>	.	.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	V	44	
<i>Plantago lanceolata</i>	+	+	+	1.2	1.2	.	1.1	+	.	+	1.2	+	+	+	.	+	V	153	
<i>Leontodon hispidus</i>	+	2.2	+	2.2	1.2	1.2	1.1	+	.	+	+	.	+	.	.	.	IV	331	
<i>Festuca rubra</i>	.	.	+	.	.	.	.	+2	.	+2	1.2	1.2	1.2	1.2	2.2	.	III	244
<i>Trifolium pratense</i>	+	+	+	+	.	+	+2	.	.	.	.	.	.	.	.	+	III	22
<i>Potentilla reptans</i>	.	.	.	.	.	.	.	+	.	+	+	+	+	.	+	.	II	19
<i>Prunella vulgaris</i>	.	+	+	+	.	.	1.1	.	.	.	.	.	.	.	.	+	II	44
<i>Festuca pratensis</i>	.	.	.	.	.	.	.	.	.	.	+2	+2	+2	.	.	+2	II	13
<i>Phleum pratense</i>	.	.	+	.	.	.	.	.	.	.	.	+	.	.	+	.	I	9
<i>Poa trivialis</i>	.	.	+	.	+	.	.	+	.	.	.	.	.	.	.	.	I	9
<i>Lolium perenne</i>	.	.	.	2.2	+	.	.	.	.	.	.	.	.	.	.	.	I	113
<i>Poa pratensis</i>	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	I	6
<i>Centaurea jacea</i>	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	I	6
<i>Rhinanthus angustifolius</i>	.	.	+2	.	.	.	.	.	.	.	.	.	.	.	.	.	I	3
<i>Taraxacum officinale</i>	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	3
ChAll. <i>Festuco-Brometea</i>																			
<i>Centaurea scabiosa</i>	+	+	2.3	+	.	+	2.2	3.3	.	1.2	+	+	+	+	.	1.1	V	541	
<i>Poa compressa</i>	.	.	+	+2	.	+	+2	.	+	+	1.2	2.2	+	+	+	+	IV	172	
<i>Plantago media</i>	2.2	1.2	+	+	1.2	3.3	.	.	1.2	.	.	.	.	+	+	1.1	IV	481
<i>Brachypodium pinnatum</i>	.	.	.	.	.	.	.	+2	.	1.3	+3	+3	+2	.	.	.	II	44
<i>Allium oleraceum</i>	.	.	.	+	.	.	.	.	.	.	.	+	.	+	.	+	II	13
<i>Scabiosa ochroleuca</i>	1.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	31
ChAll. <i>Trifolio-Geranietea</i>																			
<i>Origanum vulgare</i>	3.2	1.2	3.3	3.2	1.2	1.2	2.2	1.2	3.3	2.2	3.2	4.3	3.2	4.3	4.3	3.2	V	3156	

<i>Agrimonia eupatoria</i>	2.1	1.1	1.2	1.1	+	2.2	2.1	+	1.1	1.1	1.1	1.1	+	2.1	+	3.1	V	903
<i>Clinopodium vulgare</i>	.	.	+	+	+	1.2	.	2.2	1.2	1.2	1.2	+	1.2	2.2	2.2	.	IV	497
<i>Coronilla varia</i>	1.2	1.2	+	+	.	+	.	+	+	+	+	+	+	.	.	+	IV	94
<i>Medicago falcata</i>	1.1	+	+	+	+	3.3	1.1	.	+	.	.	.	.	.	+	.	III	316
<i>Galium verum</i>	.	.	+	.	.	+	.	.	+	.	.	.	.	.	.	.	I	9
<i>Astragalus glycyphyllos</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I	3
ChCl. Artemisietea vulgaris																		
<i>Cichorium intybus</i>	+	+	+	1.1	1.2	+	+	+	.	+	+	+	+	+	.	+	V	100
<i>Cirsium vulgare</i>	+	+	.	+	.	+	+	+	.	+	+	+	+	.	+	+	IV	38
<i>Melilotus officinalis</i>	+	+	1.1	+	.	.	+	.	.	.	+	.	.	.	+	.	III	50
<i>Carduus acanthoides</i>	.	.	.	.	.	.	.	.	.	+	+	+	+	.	.	.	III	13
<i>Cirsium arvense</i>	.	.	.	.	.	.	+	.	.	.	+	+	+	.	.	.	III	13
<i>Chaerophyllum aromaticum</i>	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	I	3
<i>Linaria vulgaris</i>	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I	3
ChCl. Rhamno-Prunetea																		
<i>Crataegus monogyna</i>	.	.	.	.	.	+	+	.	.	+	.	+	.	.	.	.	II	13
<i>Crataegus monogyna (b)</i>	.	.	.	.	.	.	.	.	1.1	.	.	.	.	.	.	.	I	31
<i>Prunus spinosa</i>	.	.	.	.	.	.	.	+	.	+	.	.	+	.	.	.	I	9
<i>Prunus spinosa (b)</i>	.	.	.	.	.	.	.	.	1.1	.	.	.	.	1.1	1.1	.	I	94
<i>Rosa canina</i>	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	I	6
<i>Rosa canina (b)</i>	.	.	.	.	.	.	.	.	+	.	.	.	.	+	+	.	I	9
<i>Cornus sanguinea</i>	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	I	3
<i>Cornus sanguinea (b)</i>	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	I	3
Others																		
<i>Ononis arvensis</i>	+	+	+	+	4.4	+	.	.	.	+	.	.	.	.	.	+	III	413
<i>Briza media</i>	+	+	+	.	.	.	.	.	2.2	.	.	+.2	.	.	+	2.2	III	234
<i>Sanguisorbia minor</i>	+	1.2	.	.	.	.	.	.	+	+	1.1	+	+	+	+	.	III	84
<i>Medicago lupulina</i>	+	1.2	.	.	.	.	.	.	.	+	+	+	+	+	.	+	III	53
<i>Convolvulus arvensis</i>	+	.	+	.	+	.	.	+	.	+	+	+	+	.	.	+	III	28
<i>Ranunculus polyanthemos</i>	.	+	+	+	+.2	+	+	+	.	.	.	.	.	.	.	.	III	22
<i>Euphorbia esula</i>	.	.	+	+	.	.	.	+	.	.	+	+	+	.	.	+	III	22
<i>Mentha arvensis</i>	.	.	.	.	+.2	1.2	.	2.2	1.2	.	.	.	.	.	.	.	II	175
<i>Hypericum perforatum</i>	1.2	+	.	.	.	.	.	+	+	.	.	.	.	+	+	.	II	47
<i>Fragaria vesca</i>	.	.	.	.	.	.	.	.	+	.	.	.	.	1.2	+	.	I	38
<i>Pimpinella saxifraga</i>	.	.	+	+	.	.	.	.	.	+	.	.	.	.	+	+	II	16
<i>Erigeron acre</i>	.	.	.	.	.	.	.	+.2	.	+	+	.	+	.	.	.	II	13
<i>Linum catharticum</i>	.	1.1	.	+	.	.	.	.	.	.	.	.	.	.	.	+	I	38
<i>Equisetum arvense</i>	.	.	.	+	.	.	1.1	.	.	.	.	.	.	.	.	+	I	38
<i>Erigeron annuus</i>	.	.	.	.	1.1	.	.	.	.	.	+	.	.	.	.	.	I	34
<i>Calamagrostis epigejos</i>	.	.	.	.	.	.	.	.	1.2	.	.	.	.	.	.	.	I	31
<i>Carex spicata</i>	.	.	.	.	.	.	.	.	.	.	+	.	+	.	+	.	I	9
<i>Elymus repens</i>	.	.	.	.	.	.	.	.	.	+	.	.	+	.	+	.	I	9
<i>Senecio jacobaea</i>	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	+	I	9
<i>Holcus mollis</i>	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	I	6
<i>Medicago xvaria</i>	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	I	6
<i>Quercus robur (b)</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	I	6
<i>Rubus caesius</i>	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	I	6
<i>Thymus pulegioides</i>	.	.	+.2	.	.	.	.	.	.	.	.	.	.	.	.	.	I	3
<i>Pyrus pyraster (b)</i>	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	I	3
<i>Pyrus pyraster</i>	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	I	3
<i>Bromus inermis</i>	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I	3
<i>Medicago sativa</i>	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	I	3
<i>Cuscuta epithimum</i>	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I	3
<i>Stellaria graminea</i>	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	3

*Management: g – grazing, m/g – mowing and grazing.

These included many plants inhabiting dry and insolated sites, e.g. *Briza media*, *Sanguisorba minor*, *Ranunculus polyanthemus*, and *Pimpinella saxifraga*.

DISCUSSION AND CONCLUSIONS

Gentiana cruciata is one of the characteristic species of the class *Festuco-Brometea*, although it can frequently be found in moderately or weakly xerothermic plant communities. In the Pieniny Mountains, the species is widespread across the entire region, where it occurs in various types of communities: from dry pastures and thermophilic meadows, xerothermic grasslands, and roadsides to thermophilic beech forests (KAŹMIERCZAKOWA 2004, KAŹMIERCZAKOWA et al. 2004, FREY & TYBUR 2012). In the Silesian Upland, the species inhabits more mesophilic grasslands from the sub-association *Adonio-Brachypodietum pinnati arrhenatheretosum* and the community *Centaurea scabiosa-Agrimonia eupatoria* (BABCZYŃSKA-SENDEK 2005). It has also been noted in communities that comprise, besides species from the class *Festuco-Brometea*, great numbers of meadow species from the class *Molinio-Arrhenatheretea* and fringe species from the class *Trifolio-Geranietea*. These communities include poorly developed xerothermic grasslands formed in post-agricultural habitats, disused quarries, embankments, and roadsides (BABCZYŃSKA-SENDEK & ANDRZEJCZUK 1997, BABCZYŃSKA-SENDEK et al. 2014).

In the area of the Strzyżowskie Foothills, there are no typical xerothermic grasslands as those occurring in other regions of Poland. Therefore, the presence of thermophilic plant patches deserves special attention. In the community with *Gentiana cruciata*, seven species from each of the classes *Festuco-Brometea* and *Trifolio-Geranietea* were found. Sites with such abundance of xerothermic plants are difficult to find in the analysed area. It is clearly dominated by meadow species from the class *Molinio-Arrhenatheretea*, since as many as 27 of these were found. The analysed phytocoenoses should be therefore classified as a thermophilic fresh meadow from the alliance *Arrhenatherion*. Occurrence of *Gentiana cruciata* in meadow communities *Arrhenatheretum elatioris brizetosum mediae* was also observed in the Przemyskie Foothills. The phytocoenoses with its share were characterised by high species richness and abundance of species from the classes *Trifolio-Geranietea* and *Festuco-Brometea* (BARABASZ-KRASNY 2011). *Gentiana cruciata* can also be found in the thermophilic Pieniny meadow *Anthyllidi-Trifolietum montani* associated with extensive land use (KAŹMIERCZAKOWA et al. 2004).

In many regions of Poland, *Gentiana cruciata* grows on poorly developed xerothermic grasslands, which may be related to destruction or abandonment thereof. More frequently, the species can be found in secondary post-agricultural and post-mining habitats as well as along roadsides (BABCZYŃSKA-SENDEK & AN-

DRZEJCZUK 1997, BABCZYŃSKA-SENDEK et al. 2014, HEISE 2010). The emergence of new localities of the species in secondary habitats indicates its long distance dispersal capability (BABCZYŃSKA-SENDEK et al. 2014).

In the area of the Foothills, xerothermic vegetation patches were regarded as part of thermophilic fresh meadows from the alliance *Arrhenatherion* (TOWPASZ 1990, BARABASZ-KRASNY 2011). Recently, a report on a Natura 2000 site in the Dynowskie Foothills titled "Łąki nad Wojkówką" has been published. The site comprises small patches of thermophilic vegetation with species composition resembling that of fresh meadows, xerothermic grasslands, and fringes. The communities described therein included a community from the class *Trifolio-Geranietea*, a community with *Hieracium bauhinii*, a community with *Melampyrum arvense-Salvia verticillata*, and a community with *Centaurea scabiosa*. *Gentiana cruciata* is extremely rare in this area and inhabits phytocoenoses from the class *Trifolio-Geranietea* (ZIAJA & WÓJCIK 2014).

In many regions of Poland, *Gentiana cruciata* is losing its localities and is regarded as a retreating species (BABCZYŃSKA-SENDEK & ANDRZEJCZUK 1997, BABCZYŃSKA-SENDEK & NOWAK 2002, BABCZYŃSKA-SENDEK 2005). The greatest threat is posed by abandonment of traditional forms of land use, which triggers successional changes in vegetation. Equally unfavourable are changes in grassland management forms, such as ploughing and afforestation, which lead to habitat loss (PIĘKOŚ-MIRKOWA & MIREK 2003). *Gentiana cruciata* was observed to disappear in sites occupied by competitive expansive (*Calamagrostis epigejos*) or invasive (*Solidago gigantea*) perennial species and some shrub species (*Prunus spinosa*) (BABCZYŃSKA-SENDEK & ANDRZEJCZUK 1997, BABCZYŃSKA-SENDEK et al. 2014). Another threat is the small population size and the inconsiderable surface area of grassland phytocoenoses comprising the species. The new *Gentiana cruciata* locality covers an area of approx. 0.5 ha, but the abundance of the species exhibits an upward trend, since the population size has increased from ca. 60 to ca. 160 individuals in several years. Undoubtedly, the grazing management in the upper part of the slope is a beneficial factor, as it limits the growth of expansive plant species.

The xerothermic grasslands in the Strzyżowskie Foothills are rare, fragmentary communities with occurrence limited to river valleys. Detailed research should be undertaken to provide profound knowledge and full characterisation thereof.

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