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The association *Veronico-Mimuletum guttati* Niemann 1965 in Pomerania

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Abstract: *Veronico-Mimuletum guttati*, a poorly known association of species-rich helophyte beds communities was characterized based on 21 phytosociological relevés. Its new 14 localities in Pomerania and floristic differentiation in Central Europe are presented. New subassociations of the *Veronico-Mimuletum guttati cardaminetosum amarae* have been distinguished on the basis of differing floristic composition. It is further differentiated into two syntaxa: spring variant noted in spring areas and typical variant noted in banks of rivers, ditches and water-logged meadows.

Key words: *Mimulus guttatus*, *Sparganio-Glycerion fluitantis*, new syntaxa, ATPOL grid, Pomerania, Central Europa

1. Introduction

Monkeyflower (*Mimulus guttatus* DC.) is native of the western North America from Alaska to northern Mexico, with an eastern limit in Montana and South Dakota (Meusel *et al.* 1978; Hultén & Fries 1986). The spread of *Mimulus guttatus* in Europe started in the 19th century (Oberdorfer 2001). In Poland, the first report dates from 1824 (Kowary) in the Sudety Mts. (Lohmeyer & Sukopp 1992). The oldest registered date of the occurrence of this species in Europe is 1812 in Great Britain, next 1814 – Scotland and 1824 – Germany (Slavík 2000). At the same period, it was recorded in Pomerania; it was seen in 1874 in Koszalin (Holzfuß 1937), in 1922 in Damnica (Misiewicz 1977) and in 1929 in Wrzeście – (leg. F. Marquardt, Herbarium SLTC = acronym: SLUPSK TEACHERS ACADEMY). The history of dispersion of this species was investigated by Piękoś (1972) who recorded the occurrence of this species at 112 localities. Nowadays, it is present most often in Lower Silesia and Pomerania. Until now, it has been recorded in 326 localities in 128 ATPOL squares (Tokarska-Guzik 2005). Monkeyflower is one of the species that uses banks of rivers, streams and lakes as well as ditches; it is rare in pastures and ruderal habitats. The aim of the present studies was to investigate distribution, differentiation and phytosociological characteristics of the *Veronico-Mimuletum guttati* Niemann 1965 community.

2. Material and methods

Field studies were carried out during the vegetative seasons of 2005-2014 in Central Pomerania which is the area between the river Łeba to the east and the river Parsęta to the west. According to Kondracki (2004), it is the eastern part of Koszalin Coastland. Phytosociological relevés were collected using the Braun-Blanquet method (Braun-Blanquet 1951; Pawłowski 1977). The classification and nomenclature of syntaxa was adopted after Ratyńska *et al.* (2010), the nomenclature of the vascular plants – after Mirek *et al.* (2002) and of the mosses – after Ochyra *et al.* (2003). Each stand was identified in a network of ATPOL squares (Zając 1978): (1) BA88 – Pomiłowo, (2) BA97 – Paprotki, (3) BA98 – Łętowo, (4) BB22 – Sińce, (5) BB41 – Łąkowo, (6) BB44 – Ogartowo, (7) BB54 – Popielewko, (8) CA43 – Charbrowo, (9) CA51 – Smołdzino, (10) CA51 – Stojcino, (11) CA70 – Leszczyce, (12) CA72 – Łupawa, (13) CA82 – Gogolewko, (14) CB00 – Broczyna (Fig. 1).

All phytosociological relevés were recorded in TURBOVEG database, and subsequently were grouped,

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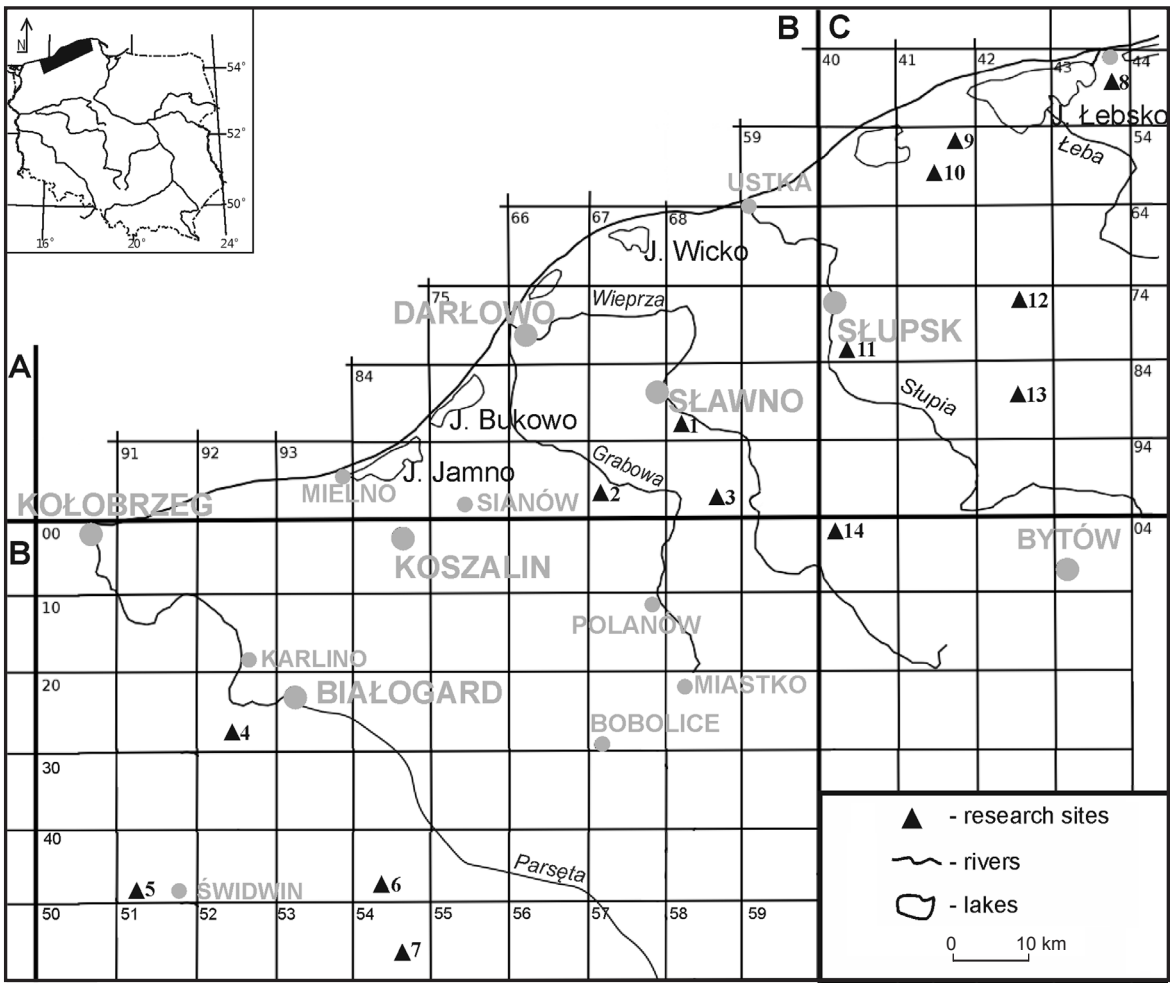

Fig. 1. Distribution of *Mimulus guttatus* in the ATPOL grid of the Central Pomerania
Explanations: a – research sites, b – rivers, c – lakes; 1-14 – localities of *Mimulus guttatus* (see in text)

making introductory evaluation of similarities by means of TWINSPAN software (Hennekens & Schaminée 2001). The set of 21 was analyzed to the 6th level after previous transformation of 7 degree Braun-Blanquet's scale into the order scale, adopting the following values: r-1, +-2, 1-3, 2-5, 3-7, 4-8, 5-9. Plant communities were classified by means of NCLAS software from SYNTAX 5.0 package (Podani 1993). Similarities between the phytosociological relevés were calculated by means of Jaccard formula on the basis of presence or lack of compared species (Fig. 2).

For statistical purposes, the quantity level according to Braun-Blanquet scale was recalculated from the phytosociological table into the cover abundance scale (Table 1).

Table 1. Abundance codes according to the Braun-Blanquet scale, with corresponding values of average coverage

Abundance code	Average coverage [%]
r	0.1
+	0.5
1	5.0
2m	7.0
2a	10.0
2b	20.0
3	37.5
4	62.5
5	87.5

3. Results

Basing on the 21 phytosociological relevés, *Veronico-Mimuletum guttati* association from the *Sparganio-Glycerion fluitantis* alliance was distinquished. The association which has not been observed so far in the territory of Pomerania or Poland appears at the rank of *V-M.g. cardaminetosum amarae* sub-association (Table 2). The characteristic species is clearly dominant in patches of *Veronico-Mimuletum guttati*. *Veronica beccabunga* co-dominates and occurs in all the relevés with another neophyte invading river habitats – *Impatiens glandulifera*. Also frequent were: *Glyceria fluitans,*

Galium palustre, Ranunculus repens, *Carex rostrata* and *C. paniculata*. It was internally differentiated into two variants: a) spring variant found in spring areas (Table 2, rel. 1-5), b) typical variant recorded in banks of rivers, ditches and water-logged meadows (Table 2, rel. 6-21). Small (1-16 m^2) patches of the typical variant appeared in the river valleys of the Dębica, Grabowa, Parsęta and Rakówka rivers and smaller effluents: the Bliska Struga River and the Charbrowska Struga River as well as at productive exudations in girdling ditches and waterflows at peatbogs in the catchment of the Słupia River. Small as to its area, patches of the spring fen origin (2-8 m^2) were found in the spring fens of the Łupawa River catchment and the outflows from spring fens of the Grabowa River catchment (Osadowski 2010).

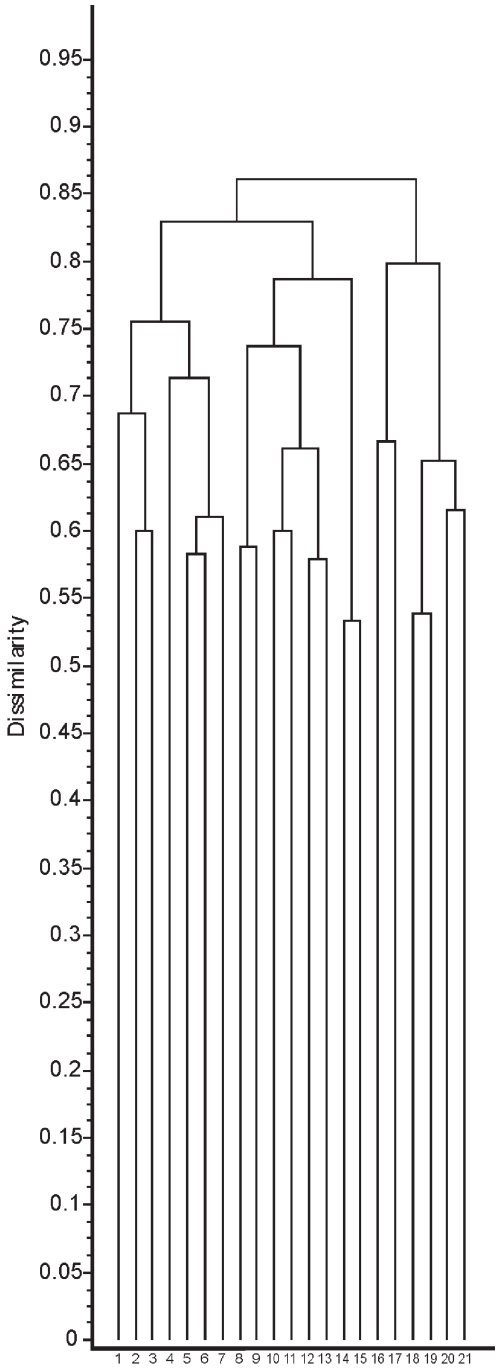

Fig 2. Classification of *Veronico-Mimuletum guttati* based on species composition in accordance with Jaccard's formula using the NCLAS program

The spring variant was florally poor (26 taxa) with dominating characteristic species: *Mimulus guttatus* and *Cardamine amara* subsp. *amara*. In individual patches, there were from 6 to 12 species (average 9). The moss layer was poorly developed. Only *Brachythecium rivulare* is worth mentioning, which appeared in the II stability class with a relatively high coverage ratio (D=76). Participation of *Cratoneuron filicinum* – moss characteristic for *Montio-Cardaminetea* class, was scarce. *Stellaria uliginosa*, which often formed dense patches of numerous procumbent shoots produced through vegetative propagation, was noted in the marshy substrate and sites of mineral-organic accumulation. In the headwater variant, patches developing along the groundwater runoff were characterised by the presence of *Lemna minor, Myosotis palustris*, and *Mentha aquatica*. The occurrence of *Urtica dioica* was associated with the substantially higher proportion of biogens in the organic accumulation sites.

The typical variant was florally rich (69 taxa). The number of species in phytocenoses of variants ranged between 6-31 (average 19). This variant occupied ditches and banks of streams. It was characterized by species composition from *Artemisieta vulgaris* (e.g. *Urtica dioica*), *Bidentetea tripartiti* (e.g. *Polygonum hydropiper, Rorippa palustris*) and *Isoëto-Nanojuncetea* (e.g. *Plantago intermedia, Juncus bufonius, Gnaphalium uliginosum*) classes. A numerous group (35 species) comprised sporadic taxons (occurring only in I constancy class).

4. Discussion

In Europe, especially in Western Europe, many species of the monkeyflower genus were cultivated as decorative plants (Stace 1997). *Mimulus guttatus* is a characteristic species of the *Sparganio-Glycerietum fluitantis* (Matuszkiewicz 2001) association. Kwiatkowski (2003) described, for the first time for Poland, the *Veronico beccabungae -Mimuletum guttati* association from the Sudety Zachodnie Mts.

The first information about the *Veronico-Mimuletum guttati* association originates from Germany, where Niemann (1965) provided its characteristics from the river valley of Thuringia. In the later period, it was reported several times in Germany and the Czech Republic (Galunder & Patzke 1989; Koch 1991; Blažková 1999; Jehlik 2000; Rennwald 2000; Korsch *et al.* 2002; Waesch 2003; Springer 2006). Differences and similarities between selected forms of the association

Table. 2. *Veronico-Mimuletum guttati* Niemann 1965 *cardaminetosum amarae* Osadowski, Sobisz, Truchan 2014 *subass. nova*. Nomenclature type: Table 2 rel. 7 (orig.) holotypus hoc loco (Niemann 1965; 429-432)

Variant	Spring											
Successive number of phytosociological relevé	1	2	3	4	5		6	7	8	9	10	11
Number of phytosociological relevé in the field	108	98	149	148	19		79	62	60	61	63	420
Phytosociological relevé area [m^2]	8	4	4	4	2		4	2	1	1	1	12
Date (day, month, year)	22.07 2007	20.07 2007	16.07 2007	18.07 2007	22.07 2007		01.07 2005	04.07 2005	01.07 2005	01.07 2005	01.07 2005	07.07 2007
Locality	Ł	BR	G	G	G		G	G	G	G	G	Sm
Coverage of herb layer [%]	100	60	70	90	100	Mean	90	80	100	80	90	100
Coverage of moos layer [%]	10	10	5	1	1		-	-	-	-	-	-
Number of species in phytosociological relevé	9	10	9	12	6	9.2	11	12	6	8	7	23
I. Ch. D. subAss. *Veronico-Mimuletum guttati*						No.O	D					
Mimulus guttatus	5	3	4	4	5	5	6750	4	4	5	3	4	3
Cardamine amara	+	.	+	1	+	4	130	+	1	2a	1	1	1
Veronica beccabunga	.	.	.	.	.			.	.	.	1	+	2a
II. Ch. *Montio-Cardaminetea*													
Brachythecium rivulare d	1	1	1	+	+	5	320	.	.	.	.	.	.
Cratoneuron filicinum d	1	1	.	.	.	2	200	.	.	.	.	.	.
Stellaria uliginosa	1	.	.	.	+	2	110	.	+	.	.	.	.
III. Ch. *Sparganio-Glycerion fluitantis*													
Berula erecta	.	+	+	+	2a	4	230	1	1	+	2a	.	1
Glyceria fluitans	.	.	.	+	.	1	10	+	1	.	.	.	1
Scrophularia umbrosa	.	.	.	.	.			.	.	.	.	.	.
Veronica anagallis-aquatica	.	.	.	.	.			.	.	.	.	.	+
IV. Ch. *Magnocaricion*													
Carex rostrata	.	.	.	.	.			.	1	2a	2a	.	1
Carex paniculata	.	.	.	.	.			.	+	.	.	2b	1
Galium palustre	.	.	.	.	.			.	1	.	.	.	+
Phalaris arundinacea	.	.	.	.	.			.	.	.	.	.	.
Iris pseudacorus	.	.	.	.	.			.	.	.	.	.	.
V. Ch. *Phragmitetea*													
Mentha aquatica	.	.	+	+	1	3	120	+	+	.	.	+	1
Phragmites australis	.	.	.	.	.			.	.	.	.	.	1
Acorus calamus	.	.	.	.	.			.	.	.	.	.	.
VI. Ch. *Molinio-Arrhenatheretea*													
Myosotis palustris	.	.	.	.	.			.	1	+	1	1	2m
Rumex acetosa	.	1	+	1	.	3	210	1	.	.	.	.	1
Ranunculus repens	.	.	+	+	.	2	20	+	.	.	.	.	1
Lythrum salicaria	.	.	.	.	.			.	+	.	.	.	1
Caltha palustris	.	.	.	.	.			.	.	.	+	.	.
Juncus effusus	.	.	.	.	.			.	.	.	.	.	.
Agrostis stolonifera	.	.	.	.	.			.	.	.	.	.	+
VII. Ch. *Bidentetea tripartiti*													
Polygonum hydropiper	.	.	.	.	.			.	.	.	.	.	1
Rorippa palustris	.	.	.	.	.			.	.	.	.	.	.
Polygonum lapathifolium subsp. *lapathifolium*	.	.	.	.	.			.	.	.	.	.	.
Bidens tripartita	.	.	.	.	.			.	.	.	.	.	.
VIII. Ch. *Artemisietea vulgaris*													
Impatiens glandulifera	.	.	.	.	.			.	.	.	.	.	.
Urtica dioica	.	.	.	+	.	1	10	+		.	.	.	1
Symphytum officinale	.	.	.	.	.			.	.	.	.	.	.
Myosoton aquaticum	.	.	.	.	.			.	.	.	.	.	.
IX. Ch. *Isoëto-Nanojuncetea*													
Juncus bufonius	.	.	.	.	.			.	.	.	.	.	1
Plantago intermedia	.	.	.	.	.			.	.	.	.	.	1
Gnaphalium uliginosum	.	.	.	.	.			.	.	.	.	.	.
X. Accompanying species													
Lemna minor	1	+	2m	2m	.	4	390	1	2m	.	.	+	+

Typical											
12	13	14	15	16	17	18	19	20	21		
654	221	367	605	611	538	334	238	589	658		
8	15	6	10	8	12	8	16	20	6		
09.08 2014	12.07 2006	02.07 2005	23.07 2013	23.07 2013	12.07 2011	28.06 2005	19.07 2006	29.06 2012	09.08 2014		
L	Po	Pa	Og	Si	Pk	Ch	Łę	Łą	St		
100	100	95	100	95	85	100	65	70	100	Mean	
-	-	-	-	-	-	1	-	-	-		
29	28	29	22	27	31	28	19	17	18	19.7	
										S	D
3	4	4	4	4	3	4	3	4	5	V	5781
1	1	+	+	1	1	1	1	+	.	V	388
+	.	+	.	1	1	.	.	.	.	III	166
.	.	.	.	.	.	.	.	.	.		
.	.	.	.	.	.	.	.	.	.		
.	.	.	.	.	.	.	.	.	.	I	3
1	+	1	+	+	1	+	.	.	.	IV	266
1	2m	.	2a	.	.	+	.	.	.	III	206
2a	.	1	1	.	+	+	.	.	.	II	131
.	+	+	.	1	+	.	.	.	.	II	44
+	1	.	+	1	.	1	2b	+	.	IV	416
+	.	1	.	.	.	.	+	+	.	III	200
.	.	1	1	1	+	+	.	.	.	III	134
.	+	.	1	+	+	.	.	+	.	II	44
.	.	1	.	+	+	.	+	+	.	II	44
1	+	+	1	.	1	+	+	.	+	IV	150
1	+	.	+	+	.	1	+	+	.	III	109
.	1	+	+	.	1	+	.	.	.	II	72
1	2a	+	+	.	2m	+	1	.	.	IV	319
+	+	.	.	1	1	+	.	.	.	III	134
+	+	+	+	+	.	.	+	+	.	III	56
+	1	.	.	1	.	.	.	.	+	II	103
1	+	1	.	+	.	.	.	.	.	II	72
+	.	.	+	+	1	+	+	.	.	II	47
+	+	+	+	.	.	.	.	.	.	II	31
.	1	+	+	.	+	+	.	+	1	III	109
1	+	+	.	+	+	.	+	.	+	III	50
.	+	+	.	+	+	+	.	.	+	II	37
.	.	+	+	+	.	+	+	.	+	II	37
1	1	1	.	.	1	1	+	2m	1	III	234
+	.	1	1	1	+	+	.	.	.	III	137
1	+	.	.	1	+	1	.	.	.	II	100
1	1	+	+	.	.	.	.	.	+	II	72
+	+	.	.	+	+	1	.	.	+		78
+	+	.	.	1	.	.	.	.	1	II	100
.	.	.	.	+	+	+	.	+	+	II	31
+	+	1	1	+	+	.	+	+	.	IV	162

Species occuring only in I constancy class: **III.** *Carex gracilis* 14 (1), 18,19 (+), *Lysimachia thyrsiflora* 14 (+), *Scutellaria galericulata* 12 (+), **IV.** *Equisetum fluviatile* 17,18 (+), *Sparganium erectum* 15 (1), 17,18 (+), **VI.** *Achillea ptarmica* 13, 14, 17 (+), *Epilobium palustre* 1, 4, 6, 8 (+), *Equisteum palustre* 2 (1), 3, 4, 6 (+), *Filipendula ulmaria* 18, 19 (+), *Galium uliginosum* 12 (+), *Juncus conglomeratus* 20 (+) *Lotus uliginosus* 20 (+), *Lysimachia nummularia 20 (+), Lysimachia vulgaris* 17 (1), 18 (+), *Odontites serotina* 21 (+), *Potentilla anserina* 21 (+), *Ranunculus acris* 2 (+), *Scirpus sylvaticus* 16, 21 (+), 17 (1), **VII.** *Bidens frondosa* 12 (+), **VIII.** *Artemisia vulgaris* 14 (+), 15 (+), *Chenopodium album* 16 (1), 17, 18 (+), *Cirsium arvense* 13, 14, 17 (+), *Epilobium hirsutum* 14 (1), 18, 19 (+), *E. parviflorum* 1(+), *Galeopsis speciosa* 11 (+), *Melandrium album* 21 (+), *Melilotus alba* 11, 12 (+), *Rumex obtusifolius* 1 (+), *Tanacetum vulgare* 16, 17, 20 (+), **X.** *Dryopteris carthusiana* 2, 13 (+), *Lycopus europaeus* 19 (+), *Mnium hornum* d 2, 19 (+), *Poa annua* 21 (+), *Polygonum persicaria* 20 (+), *Solanum dulcamara* 21 (+)

Explanations: BR – Broczyna, Ch – Charbrowo, G – Gogolewko, L – Leszczyce, Ł – Łupawa, Łą – Łąkowo, Łę – Łętowo, Og – Ogartowo, Pa – Paprotki, Pk – Popielewko, Po – Pomiłowo, Si – Sińce, Sm – Smołdzino, St – Stojcino; No.O – number of occurrence, S – phytosociological stability, D – cover coefficient

Table 3. Floristic differentiation of *Veronico-Mimuletum guttati* Niemann 1965 in Central Europa

References/Source	A	B	C	D	E1	E2
Number of phytosociological relevés	15	5	10	12	5	16
Number of species in phytosociological relevé	52	27	48	66	12	54
Ch. *Veronico-Mimuletum guttati*						
Mimulus guttatus	V^{+-4}	5^{+-5}	V^{+-5}	V$^{1-5}$	5^{+-5}	V$^{3-5}$
Veronica beccabunga	IV^{+-4}	.	.	III^{+-2}	.	III^{+-2}
*Epilobium roseum**	III^{+-2}	.	.	III^{+-2}	.	.
*Cardamine amara**	III^{+-2}	.	II^{+-2}	.	4^{+-2}	III^{+-2}
Ch. *Sparganio-Glycerion fluitantis*						
Glyceria fluitans	IV^{+-4}	1^{+}	II^{+-1}	III^{+-1}	1^{+}	III^{+-2}
Nasturtium officinalis	I^{+-4}	.	.	I^{+}	.	.
Veronica anagallis-aquatica	I^{+}	.	.	.	.	II^{+-1}
Scrophularia umbrosa	.	.	I^{+}	II^{+}	.	II^{+-2}
Leersia oryzoides	.	.	I^{+}	.	.	.
Berula erecta	.	.	.	.	4^{+-1}	IV^{+-2}
Ch. *Montio-Cardaminetea*						
Brachythecium rivulare d	.	.	.	.	5^{+-1}	.
Stellaria uliginosa	.	.	.	.	2^{+-1}	.
*Cratoneurion filicinum*d	.	.	.	.	2^{1}	.
Ch. *Magnocaricion*						
Phalaris arundinacea	II^{+}	.	III^{+-1}	II^{+-1}	.	II^{+-1}
Galium palustre	IV^{+-4}	.	.	I^{+}	.	III^{+-1}
Carex gracilis	I^{+}	.	.	I^{+}	.	I^{+-1}
Iris pseudacorus	I^{+}	.	.	I^{+}	.	II^{+-1}
Poa palustris	.	2^{+-1}	.	II^{+-1}	.	.
Carex rostrata	I^{+}	.	.	.	.	IV^{+-2}
Carex paniculata	.	.	.	.	.	III^{+-2}
Lysimachia thyrsiflora	.	.	.	.	.	I^{+}
Scutellaria galericulata	.	.	.	.	.	I^{+}
Ch. *Phragmitetea*						
Eleocharis palustris	I^{+-2}	.	.	I^{+}	.	.
Rorripa amphibia	.	.	I^{+}	I^{+-2}	.	.
Equisetum fluviatile	I^{+}	.	.	.	.	I^{+}
Alisma plantago-aquatica	I^{+}	.	.	.	.	.
Acorus calamus	.	.	.	II^{+-1}	.	II^{+-1}
Sparganium erectum	.	.	.	I^{+-2}	.	I^{+-1}
Phragmites australis	.	.	.	I^{+-2}	.	III^{+-1}
Mentha aquatica	.	.	.	.	3^{+-1}	IV^{+-1}
Ch. *Molinio-Arrhenatheretea*						
Ranunculus repens	IV^{+-2}	.	II^{+-2}	I^{+}	2^{+}	III^{+-1}
Myosotis palustris	II^{+-1}	3^{+-1}	II^{+-1}	IV^{+-4}	.	IV^{+-2}
Agrostis stolonifera	I^{+}	1^{+}	.	III^{+-3}	.	II^{+}
Juncus effusus	I^{+}	5^{+-1}	.	I^{+}	.	II^{+-1}
Achillea ptarmica	II^{+-1}	.	.	I^{+}	.	I^{+}
Galium uliginosum	II^{+-1}	.	.	I^{+}	.	I^{+}
Lysimachia nummularia	I^{+}	.	.	I^{+}	.	I^{+}
Lythrum salicaria	.	.	I^{+}	I^{+-2}	.	II^{+-1}
Lotus uliginosus	IV$^{1-2}$	.	.	.	.	I^{+}
Equisetum palustre	I^{+}	.	.	.	.	I^{+-1}
Caltha palustris	I^{+-2}	.	.	.	.	II^{+-1}
Juncus conglomeratus	I^{+-2}	.	.	.	.	I^{+}
Filipendula ulmaria	I^{+-2}	.	.	.	.	I^{+}
Scirpus sylvaticus	I^{+}	.	.	.	.	I^{+-1}
Rumex acetosa	.	.	.	.	3^{+-1}	III^{+-2}
Lysimachia vulgaris	.	.	.	.	.	I^{+-1}
Potentilla anserina	.	.	.	.	.	I^{+}
Ranunculus acris	.	.	.	.	.	I^{+}
Epilobium palustre	.	.	.	.	.	I^{+}

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Number of phytosociological relevés	15	5	10	12	5	16
Number of species in phytosociological relevé	52	27	48	66	12	54
Odontites serotina	.	.	.	.	.	I^{+}
Sanguisorba officinalis	.	.	.	I^{+}	.	.
Ch. *Bidentetea tripartiti*						
Polygonum hydropiper	.	5^{1-2}	II^{+-1}	I^{+-2}	.	III^{+-1}
Rorippa palustris	.	5^{+-2}	II^{+}	V^{+-4}	.	III^{+-1}
Polygonum lapathifolium subsp. *lapathifolium*	.	1^{+}	II^{+-1}	V^{+-3}	.	II^{+}
Bidens tripartita	.	.	.	IV^{+-4}	.	II^{+}
Bidens frondosa	.	.	IV^{+-3}	.	.	I^{+}
Rumex maritimus	.	.	I^{+}	.	.	.
Bidens radiata		2^{+}	.	.		.
Alopecurus aequalis	.	.	.	II^{+-1}	.	.
Bidens cernua	.	.	.	I^{+}	.	.
Ranunculus sceleratus	.	.	.	I^{+}	.	.
Ch. *Artemisietea vulgaris*						
Rumex obtusifolius	II^{+}	2^{+}	II^{+-1}	I^{+}	.	I^{+}
Mentha longifolia	II^{+-1}	.	II^{+-1}	III^{+-1}	.	.
Urtica dioica	.	.	IV^{+-2}	I^{+}	1^{+}	III^{+-1}
Epilobium hirsutum	.	.	II^{+-1}	I^{+}	.	I^{+-1}
Tanacetum vulgare	.	.	I^{+}	II^{+-1}	.	I^{+}
Artemisia vulgaris	.	.	I^{+-2}	I^{+-1}	.	I^{+}
Symphytum officinale	.	.	I^{+-2}	II^{+}	.	II^{+-1}
Chenopodium album	.	.	I^{+}	I^{+}	.	I^{+-1}
Capsella bursa-pastoris	.	1^{+}	.	I^{+}	.	.
Calystegia sepium	.	.	I^{+}	.	.	.
Cirsium arvense	.	.	I^{+}	.	.	I^{+-1}
Melilotus alba	.	.	I^{+}	IV^{+-2}	.	I^{+-1}
Myosoton aquaticum	.	.	.	II^{+-1}	.	II^{+-1}
Impatiens glandulifera	.	.	.	.	.	III^{+-1}
Galeopsis speciosa	.	.	.	.	.	I^{+-1}
Epilobium parviflorum	.	.	.	.	.	I^{+}
Melandrium album	.	.	.	.	.	I^{+}
Saponaria officinalis	.	.	.	I^{+}	.	.
Barbarea vulgaris	.	.	.	I^{+}	.	.
Senecio viscosus	.	.	.	I^{+}	.	.
Ch. *Isoëto-Nanojuncetea*						
Plantago intermedia	.	1^{+}	II^{+-2}	I^{+}	.	II^{+-1}
Juncus bufonius	.	5^{+-2}	I^{+}	I^{+}	.	III^{+-1}
Gnaphalium uliginosum	.	5^{+-2}	.	IV^{+-2}	.	II^{+}
Limosella aquatica	.	1^{+}	.	I^{+}	.	.
Accompanying species						
Poa trivialis	I^{+-2}	.	I^{+}	.	.	.
Holcus lanatus	I^{+}	.	.	I^{+}	.	.
Epilobium obscurum	II^{+}	.	.	I^{+}	.	.
Polygonum persicaria	.	2^{+-2}	II^{+-2}	.	.	I^{+}
Poa annua	.	1^{+}	I^{+}	.	.	I^{+}
Lycopus europaeus	.	.	.	III^{+-2}	.	I^{+}
Lemna minor	.	.	.	.	4^{+-2}	IV^{+-2}
Dryopteris carthusiana	.	.	.	.	.	I^{+}
Mnium hornum d	.	.	.	.	.	I^{+}
Solanum dulcamara	.	.	.	.	.	I^{+}
Other accompanying species	20	9	18	15	14	15

Explanations: A – Niemann E. 1965, B – Galunder R. & Patzke E. 1989, C – Blažková D. 1999, D – Kwiatkowski P. 2003, E – Sobisz Z., Osadowski Z., Truchan M. 2014 (unpubl.), 1 – spring variant, 2 – typical variant

are presented in Table 3. In each case, *Mimulus guttatus* was provided as a species characteristic for the association under consideration. Moreover, in patches of the association, species from the remaining syntaxa were noted: *Glyceria fluitans, Myosotis palustris* and *Rumex obtusifolius*. The differences refer to participation of some species or ecological groups. In Niemann's material (1965) *Galium palustre, Lotus uliginosus* appear more often, especially the meadow plants of the *Molinietalia* order, and there is a complete lack of the species of *Bidentetea tripartiti* and *Isoëto-Nanojuncetea* classes. The comparison of the forms of the association from the river valleys of Hessia (Galunder & Patzke 1989) with the material of the authors from the river basin of the Parsęta River and the Słupia River reveals a more important role of the species of riparian therophytes (*Bidentetea tripartiti*) and silt soil plants (*Isoëto-Nanojuncetea*). In the phytosociological relevés from the Bóbr River valley (Kwiatkowski 2003), a big participation of rushes taxa draws our attention from the connections of *Sparganio-Glycerion fluitantis* and *Magnocaricion* alliances as well as *Phragmitetea* and *Artemisietea vulgaris* classes. Similarly, floristic relationships were observed by the authors of the study. In the river valleys of the Grabowa River, the Łupawa River, the Rakówka River and minor waterflows, a larger number of species of the *Molinietalia* order was found. However, in the river valley of the Berounka River in the river basin of the Vltawa River (Blažková 1999), a minimum participation of the rushes species draws our attention and the increased presence of *Bidens frondosa* – a species not found in the forms from Germany or the Czech Republic. In Central Pomerania, the authors discovered it in the Słupia River valley and the valley of the Charbrowska Struga River. In Poland, it was recognized as an invasive species (Urbisz *et al.* 2009). *Impatiens glandulifera* found along the banks of the Bliska Struga River, the Rakówka River and the Słupia River, drainage ditches and land depressions on Łętowo Lake and Oparzno Lake has a similar status (Tokarska-Guzik *et al.* 2012). A comparison of the number of species in the syntaxonomic groups revealed an increased proportion of meadow species from the *Molinio-Arrhenatheretea* class, ruderal species from the *Artemisietea vulgaris* class, and rush species from the *Magnocaricion* alliance in the area of Pomerania (Table 4).

Data collected so far from European countries indicate a potential threat posed by competition from *Mimulus guttatus* and, in the area of dense patches, its impact on the species composition and structure of communities with *Sparganio-Glycerion fluitantis* (Tokarska-Guzik & Dajdok 2010). This phenomenon seems to be of special importance in legally protected areas, in particular, in the Słowiński National Park (Piotrowska *et al.* 1997). The biological features of *Mimulus guttatus* promote efficient generative propagation of the species through highly germinable seeds and vegetative spread through fragments of rooting shoots and stolons (Truscott *et al.* 2006). The diversity of the habitat conditions in the headwater niches is reflected in their floristic diversity. The headwater areas are colonised by crenophytes, which tolerate the low temperature of spring waters. Plants inhabiting these areas may be highly specific to them or may also occur elsewhere. They include *Berula erecta*, an obligate crenophyte occurring exclusively in springs, and *Carex paniculata* and *Scirpus sylvaticus*, facultative crenophytes growing both in headwater areas and elsewhere.

5. Conclusions

- A subassociation of *Veronico-Mimuletum guttati cardaminetosum amarae*, unknown so far, was dis-

Table 4. Number of species in each syntaxonomic group of the association *Veronico-Mimuletum guttati* Niemann 1965 in Central Europe

References/Source	A	B	C	D	E	
Number of phytosociological relevés	15	5	10	12	5	16
Number of species in phytosociological relevé	52	27	48	66	12	54
Ch. *Veronico-Mimuletum guttati*	4	1	2	3	2	3
Ch. *Sparganio-Glycerion fluitantis*	3	1	3	3	2	4
Ch. *Montio-Cardaminetea*	.	.	.	.	3	.
Ch. *Magnocaricion*	5	1	1	5	.	8
Ch. *Phragmitetea*	3	.	1	5	1	5
Ch. *Molinio-Arrhenatheterea*	10	2	2	5	.	15
Ch. *Bidentetea tripartiti*	.	4	5	7	.	5
Ch. *Artemisietea vulgaris*	10	2	2	5	.	15
Ch. *Isoëto-Nanojuncetea*	.	4	2	4	.	3
Accompanying species	6	3	4	6	3	12
Other accompanying species	20	9	18	15	14	15

tinguished. The said subassociation is characterized by a very high participation of *Mimulus guttatus* and *Cardamine amara* subsp. *amara*.

- *Veronico-Mimuletum guttati* is a member of the *Sparganio-Glycerion fluitantis* alliance. Sometimes, the species occurs in phytocoenoses of other communities of the *Phragmitetea, Bidentetea tripartiti* and *Isoëto-Nanojuncetea* classes.
- Within the *V-M.g. cardaminetosum amarae* subassociation, two variants were distinguished: spring fen and typical variants. The spring fen variant is characterized by a constant presence of *Cardamine amara* subsp. *amara* and other characteristic species for the *Montio-Cardaminetea* class. Participation of the monkeyflower in the group of spring fen associations indicates that it is a good phytoindicator of the increased levels of biogenic substances in outflows.
- The analysis of similarities between the selected forms of the association from Central Europe revealed a constant share of the characteristic species *Mimulus guttattus* and *Veronica beccabunga* and occurrence of species representing the other syntaxa, i.e. *Glyceria fluitans, Myosotis palustris,* and *Rumex obtusifolius*, in the patches of the association. The differences were visible in the share of some species or syntaxonomic groups with the notably increased proportion of meadow species from the *Molinio-Arrhenatheretea* class*,* ruderal species from the *Artemisietea vulgaris* class, and rush species from the *Magnocaricion* alliance.
- Establishment of a possible scale of variability of that association requires constant monitoring and analysis of richer phytosociological materials, especially in the remaining part of Pomerania.

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