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Revised distribution and plant communities of *Orobanche alsatica* and notes on the Orobanchaceae series *Alsaticae* in Poland

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Abstract: The paper presents the current distribution of *Orobanche alsatica* in Poland, based on a critical revision of herbarium and literature data and on my field studies conducted in 2006-2011. The recorded localities are mainly in Polish Uplands: the Lublin Upland (Wyżyna Lubelska), Roztocze, and Polesie, less frequently in the Małopolska Upland (Wyżyna Małopolska) and Silesia-Kraków Upland (Wyżyna Śląsko-Krakowska). Distribution maps of *O. alsatica* and other species of the series *Alsaticae* (*O. bartlingii* and *O. mayeri*) in Poland are included. Their taxonomy, biology, ecology, and habitat preferences are also discussed.

Key words: *Orobanche alsatica*, series *Alsaticae*, Orobanchaceae, distribution, phytocoenoses, Poland

1. Introduction

Orobanche alsatica Kirschl. (Orobanchaceae) belongs to the section *Orobanche*, series *Alsaticae* Teryokhin (Teryokhin *et al*. 1993). The series *Alsaticae* in Poland is also represented by *O. bartlingii* and *O. mayeri*. Their occurrence in Poland and ecological conditions were presented previously (Piwowarczyk *et al*. 2009; Piwowarczyk 2011a). The present study is focused on *O. alsatica*, but it also briefly discusses some taxonomic and ecological issues in the series *Alsaticae*.

Orobanche alsatica is a European-West Asian species. Its range extends from western France, Central Europe (i.e. N Switzerland, Austria, NE Germany, Poland), the Baltic states, former Yugoslavia, and Romania, to eastern Europe, Asia Minor, the Caucasus, Siberia, reaching China (Kreutz 1995; Pusch & Günther 2009). Its range cannot be accurately specified due to ambiguities in the taxonomic approaches and the poor recognition of the species.

Orobanche alsatica mostly parasitizes *Peucedanum cervaria* and sporadically *P. alsaticum* and *Seseli* sp. It usually flowers from late June to July (August) (Kreutz 1995; Zázvorka 1997, 2000).

Most locations are in arid and semi-arid low grasslands, bordering on open oak forests and dry pine forests, in dry thickets along forests, in forest glades, and on open, rocky ground, in old vineyards and orchards, quarries, in warm and sunny places on alkaline substrates: loamy and calcareous soil, such as limestone, conglomerate, basalt. The species mostly prefers sun-exposed slopes and hills, inclined 3-30°, S-, SSW-facing, less frequently N-facing (Uhlich *et al*. 1995; Zázvorka 1997, 2000). It is reported from lowland to upland sites, rarely from montane and subalpine areas (Kreutz 1995; Zázvorka 2000). Its altitudinal range is 160-200 m (rarely 1450 m) in Slovakia (Zázvorka 1997), 250-400 m (rarely 780 m) in the Czech Republic (Zázvorka 2000), up to 1500 m in the Alps (Uhlich *et al*. 1995; Pusch & Günther 2009), and up to 1900 m in the Caucasus (Uhlich *et al*. 1995). This information, however, is very general and describes *O. alsatica* agg.

Reports on plant communities preferred by the species are very scarce. They are only general and usually list communities of the syntaxa *Geranion sanguinei* (Uhlich *et al*. 1995; Zázvorka 1997; Pusch & Günther 2009), *Geranio-Peucedanetum cervariae*, *Geranio sanguinei-Dictamnetum*, *Mesobromion*,

Astragalo-Stipion, *Bromion* (Uhlich *et al*. 1995), *Prunion fruticosae* (Zázvorka 1997, 2000; Koštál 2011), *Prunion spinosae* (Hadinec & Lustyk 2008), *Festucetum sulcatae balcanicae* (Soó 1968), *Festucion rupicolae* (Soó 1968), *Quercion pubescentis-petraeae* (Soó 1968; Zázvorka 1997, 2000), *Calamagrostion variae* (Zázvorka 1997), *Seslerio-Asterion alpini* (Zázvorka 1997), *Dauco-Melilotion* (Zázvorka 2000), *Festuco-Brometea*, and *Festucion valesiacae* (Zázvorka 1997, 2000).

Orobanche alsatica is included in the Polish red data book as an endangered species (EN) (Piwowarczyk 2012a). It is also red-listed in Poland in the E category (Zarzycki & Szeląg 2006) and considered to be regionally extinct or endangered on red lists for Lower Silesia – RE (Kącki *et al*. 2003), Western Pomerania – Ex (Żukowski & Jackowiak 1995), Pomerelia (Pomorze Gdańskie) – EN (Markowski & Buliński 2004), the Kuyavian-Pomeranian Region – I (Indeterminate) (Rutkowski 1997), Sudety Mts. – Ex (Fabiszewski & Kwiatkowski 2002), Opole Province – RE (Nowak *et al*. 2003, 2008), and Upper Silesia – E (Parusel *et al*. 1996) and later CR (Urbisz & Parusel 2012). The other species of the series *Alsaticae* occurring in Poland are also very rare and threatened. They are included in Polish red books and the red list: *O. bartlingii* – VU (Szeląg 2001b, 2012), R (Zarzycki & Szeląg 2006); *O. mayeri* – CR (Piwowarczyk 2012c). All species of the genus *Orobanche* are strictly protected in Poland (Regulation 2012). Species of the series *Alsaticae* are very rare and threatened also in neighbouring countries, such as Germany, the Czech Republic, and Slovakia (Korneck *et al*. 1996; Procházka 2001; Feráková *et al*. 2001).

The aim of my study was to identify the distribution of *Orobanche alsatica* in Poland, based on my field investigations as well as verified herbarium and literature data. The distribution, preferred habitats, communities, hosts, and taxonomic problems in the series *Alsaticae* are also discussed below.

2. Materials and methods

Field investigations were conducted between 2006 and 2011. All available herbarium materials of *Orobanche alsatica* in Poland were also revised. Herbarium materials of *O. alsatica* deposited in herbaria LBL, KRAM, KTC, OPOL, TRN and in Vienna (W) were examined. Herbarium acronyms are given after Mirek *et al*. (1997). The nomenclature of vascular plants follows Mirek *et al*. (2002). The nomenclature of syntaxa is based on Matuszkiewicz (2006). The localities are listed in the Atlas of Distribution of Vascular Plants in Poland (ATPOL) cartogram units, 10 km × 10 km (Zając 1978, see also http://www.ib.uj.edu.pl/chronpol/). The units are arranged alphabetically. Only localities recorded in my observations and identified or confirmed, as well as verified herbarium data, are listed below. Published data not confirmed by me in the field or undocumented by herbarium material are not included, due to frequent determination errors. A list of erroneously identified locations is given below, with comments. Localities are described as follows: ATPOL grid unit, geographic location, habitat description, abundance (in bracket), and for most localities also geographic coordinates and elevation (above sea level). For revised exsiccata, the following information is given: the collector and collection date, herbarium acronym and the exsiccatum number.

3. Results

3.1. Taxonomic notes

Orobanche alsatica Kirschleger Prodr. Fl. d'Alsace 109, 1836. – Syn. *O. cervariae* Kirschleger Flora, Regensburg 18: 303, 1835, nom. nud.; Suard in Gordon, Fl. Lorr. 2: 180, 1843; *O. brachysepala* F. W. Schultz, Arch. Fl. Fr. et All. I: 69 et 89, in Flora 808, 1844; *O. alsatica* var. *cervariae* (Suard) Beck in Halácsy & Braun, Nachtr. Fl. Nieder-Österr. 130, 1882; *O. alsatica* var. *alsatica* Buia, Fl. Rep. Pop. Rom. VIII: 68, 1961; Gilli in Hegi, Ill. Fl. Mitteleur. 3, 6: 498, 1974; *O. alsatica* subsp. *alsatica* Pusch, Sommerw.-Arten Krs. Artern 2. ed.: 59, 1996; Pusch & Günther in Hegi, Ill. Fl. Mitteleur. 6, 1A: 77, 2009. Type: Collines calc. à Tukheim pres de Colmar, à Dorlischeim (Alsace, France; STR).

Orobanche alsatica belongs to the section *Orobanche*, subsection *Orobanche*, series *Alsaticae* Teryokhin (Teryokhin *et al*. 1993). In older approaches it was included within the grex *Curvatae* Beck (Beck 1930). In Europe this polymorphic taxon is usually divided into 3 species, sometimes treated as subspecies or varieties:

- *O. alsatica* [=var. *typica* G. Beck, subsp. *alsatica*], parasitic on *Peucedanum cervaria* (rarely on *P. alsaticum, Seseli osseum, S. montanum, Angelica* sp.;
- *O. bartlingii* Grisebach [=var. *libanotidis* (Ruprecht) Beck, subsp. *libanotidis* (Ruprecht) Tzvelev], parasitic on *Libanotis pyrenaica* (in Russia also on *L. sibirica,* rarely on *Pimpinella* sp.);
- *O. mayeri* (Suess. & Ronniger Bertsch & F. Bertsch) [=var. *mayeri* Suess. & Ronniger, subsp. *mayeri* (Suess. & Ronniger) C. A. J. Kreutz] on *Laserpitium latifolium* (in Slovakia also sporadically on *Pimpinella major* subsp. *rhodochlamys*).

It is a problematic complex of species, poorly recognized, treated as different taxonomic units, in the rank of varieties (Beck 1930; Süssenguth & Ronniger 1942; Gilli 1974), subspecies (Rothmaler *et al*. 2002; Pusch

& Günther 2009), combined into a complex comprising *O. alsatica* and *O. bartlingii* (Zázvorka 2000), with *O. mayeri* being a separate species (Zázvorka 1997), or all 3 treated as separate species (e.g. Bertsch & Bertsch 1948; Nieschalk & Nieschalk 1974; Royer *et al*. 1992; Kreutz 1995; Kotov 1999; Pujadas & Gómez 2000; Szeląg 2001a, 2001b; Senghas & Seybold 2003; Mayevsky 2006; Tzvelev 2006; Carlón *et al*. 2009; Piwowarczyk *et al*. 2009; Piwowarczyk 2011a). The 3 species occur in Poland, where they are clearly distinguished and their preferred plant communities and hosts differ (Piwowarczyk *et al*. 2009, 2011; Piwowarczyk 2011a). Morphological differences between *O. alsatica*, *O. bartlingii*, and *O. mayeri* are identified in a study by Pujadas and Gómez (2000). *O. bartlingii* and *O. alsatica* are the most difficult species to distinguish. *O. bartlingii* has more graceful built and smaller flowers (12-17, shorter than 20 mm). It differs from *O. alsatica* by the curve of the dorsal line, glandular style, and the place of insertion of stamens (1-3 mm above the base of the corolla tube); it parasitizes *Libanotis pyrenaica*. *O. alsatica* has larger flowers (longer than 20 mm) and stamens inserted at 4-7 mm; it usually parasitizes *Peucedanum cervaria* (Beck 1930; Kreutz 1995; Szeląg 2001a, 2001b; Piwowarczyk *et al*. 2009). *O. elatior* Sutton (parasitic on *Centaurea scabiosa*) is morphologically similar to *O. alsatica* and can be easily mistaken with it.

Probably endemic taxa are also reported in the series *Alsaticae*: *Orobanche ingens* (G. Beck) Tzvelev on *Heracleum* sp. in the Caucasus (Tzvelev 1990) (probably similar to var. *heraclei*) and *O. yuennanensis* (G. Beck) Handel-Mazzetti on *Origanum* sp. in China (Zhang & Tzvelev 1998). A recently described species *O. montserratii* A. Pujadas & D. Gómez from the Spanish Pyrenees, parasitic on *Laserpitium nestleri* and *L. latifolium* (Pujadas & Gómez 2000), is also included in this series.

A variety of other, lower taxonomic units, treated differently by various authors, have also been described within *Orobanche alsatica*. These are probably morphotypes with rather narrow ranges, i.e. var. *seseli* Petitm. parasitic on *Seseli montanum* (France, Lorraine)

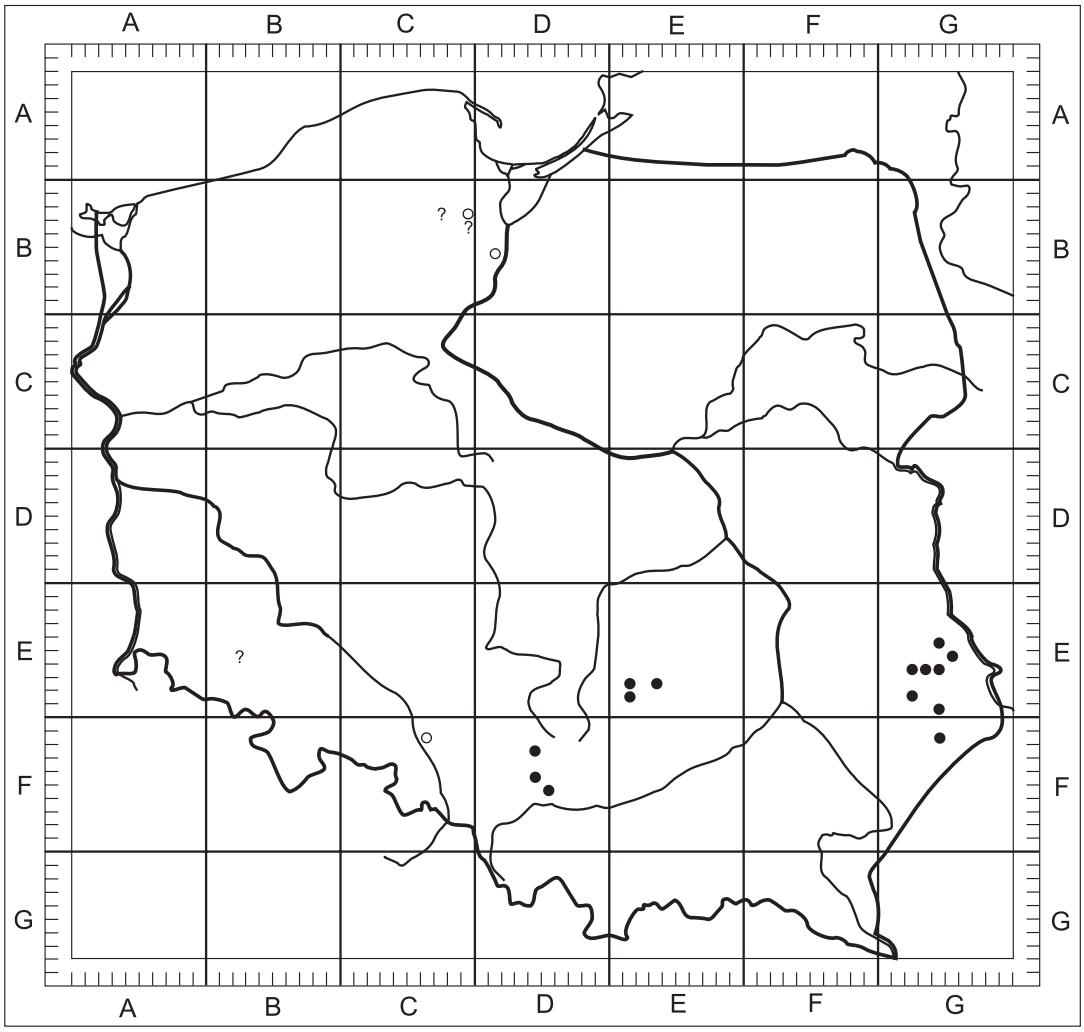

Fig. 1. Distribution of *Orobanche alsatica* in Poland
Explanations: ○ – probably extinct, ● – present, ? – literature data, difficult to differentiate, probably *O. bartlingii*.

Table 1. Plant communities with *Orobanche alsatica* in Poland

No. of relevé	1	2	3	4	5	6	7	8
Location	Korzecko	Zabłoty Mt 1	Zabłoty Mt 2	Zabłoty Mt 3	Orłów Murowany	Wolwinów	Horeszkowice	Łabunie
Date	26.09.2007	30.07.2008	30.07.2008	30.07.2008	11.07.2008	11.07.2008	12.07.2008	13.07.2008
Latitude [N]	50°47'42"	50°51'23,1"	50°51'23,5"	50°51'23"	50°54'27,3"	51°06'59"	50°56'21"	50°39'10"
Longitude [E]	20°24'11"	20°14'44,6"	20°14'43,3"	20°14'43,4"	23°14'25"	23°30'49"	23°49'28"	23°24'56"
Altitude a.s.l. [m]	315	323	282	287	240	200	210	240
Area of relevé (m^2)	25	25	25	25	20	25	50	50
Exposure	S	SW	S	S	S	SE	SSE	N
Inclination [°]	15	15	10	10	15	5	5	5
Cover of tree layer A (%)	50	40	50	60	20	20	30	80
Cover of shrub layer B (%)	15	30	15	30	30	60	20	15
Cover of herbaceus layer C (%)	90	75	80	95	60	75	95	100
Cover of moss layer D (%)	5	5	5	5	>5	>5	>5	15
Number of species	35	30	42	39	21	27	43	46
Orobanche alsatica	+	+	+	+	+	+	+	+
ChCl. *Querco-Fagetea*, ChO. *Fagetalia sylvaticae*								
Melica nutans	+	+	+	+	+	.	.	+
Fagus sylvatica B	.	.	.	.	1	+	1	.
Corylus avellana B	+	.	.	.	.	+	2	.
Hepatica nobilis	.	.	1	+	+	.	.	+
Tilia cordata B	.	+	+	.	2	.	.	.
Lilium martagon	+	.	+	+	.	.	.	+
Tilia cordata C	.	.	+	.	+	.	.	.
Galium schultesii	3	.	.	+	.	.	.	.
Lathyrus vernus	+	.	+	.	+	.	.	.
Corylus avellana C	.	.	.	.	.	.	+	.
Euonymus verrucosus C	.	.	.	+	+	.	.	.
Fagus sylvatica A	.	.	.	.	2	.	2	.
Tilia cordata A	.	2	.	.	.	.	.	.
Pulmonaria obscura	.	.	.	.	+	.	.	+
ChO. *Quercetalia pubescenti-petreae*								
Melittis melisophyllum	+	.	+	+	+	.	+	.
Hypericum montanum	+	+	+	+	.	.	.	.
Lathyrus niger	+	+	+	.	.	.	.	.
Campanula persicifolia	+	+	.	.	.	.	.	.
ChAll. *Potentillo albae-Quercion petraeae*								
Calamagrostis arundinacea	+	+	1	+	.	.	+	.
Carex montana	.	+	1	+	.	.	.	+
Convallaria majalis	+	.	2	+	1	.	.	.
Potentilla alba	+	+	+	+	.	.	.	.
Serratula tinctoria	+	.	+	+	.	.	.	.
Pulmonaria angustifolia	.	.	+	+	.	.	.	.
Festuca amethystina	.	.	+	+	.	.	.	.
Galium boreale	.	.	.	.	.	.	+	1
Vicia cassubica	+	.	+	.	.	.	.	.
ChCl. *Trifolio-Geranietea sanguinei*								
Galium verum	.	1	1	+	+	+	+	+
Origanum vulgare	.	.	+	+	.	+	1	+
Melampyrum nemorosum	1	1	1	+	+	+	+	+
Coronilla varia	+	.	.	+	+	+	+	+
Clinopodium vulgare	1	+	+	.	.	.	+	+
Astragalus glycyphyllos	.	.	.	.	.	.	+	+
Vicia tenuifolia	.	.	.	.	.	.	.	.
ChAll. *Geranion sanguinei*								
Peucedanum cervaria	3	3	3	4	1	2	2	3
Medicago falcata	.	.	.	.	.	+	+	+
Agrimonia eupatoria	+	.	.	.	.	+	+	+
Anemone sylvestris	.	.	.	.	.	.	+	+
Trifolium rubens	.	.	.	r	.	.	.	+
Anthericum ramosum	.	.	+	1	.	.	.	.
Trifolium alpestre	+	.	+	+	.	.	1	.
Polygonatum odoratum	+	+	+	+	.	.	.	+
Trifolium medium	.	.	.	.	.	.	1	+
Peucedanum oreoselinum	.	.	+	.	.	.	.	.
Geranium sanguineum	.	.	.	.	.	.	.	.
Campanula rapunculoides	+	.	.	.	.	.	.	+
ChCl. *Festuco-Brometea*								
Brachypodium pinnatum	3	4	3	2	3	4	3	2
Euphorbia cyparissias	.	+	+	.	.	.	.	.
Centaurea scabiosa	.	.	.	.	.	.	+	.
Campanula glomerata	.	.	+	+	.	.	.	.
Stachys recta	.	+	+	+	.	.	.	.
Salvia verticillata	.	.	.	.	.	+	.	.
Teucrium chamaedrys	.	.	.	.	.	.	.	.

9	10	11	12	13	
Kąty	Broczówka	Biała Góra	Grabina Mt	Jaworzno NE	
13.07.2008	13.07.2008	28.06.2008	15.06.2009	13.08.2010	
50°40’33”	50°52’05”	50°28’33”	50°52’22,3”	50°12’13”	C
23°07’22”	23°22’05”	23°28’44”	20°34’40,2”	19°23’39”	o
280	240	330	302	330	n
25	50	25	25	25	s
S	SW	SSW	S	N	t
15	20	20	10	15	a
30	20	10	-	-	n
40	40	20	-	-	c
95	100	95	95	100	y
10	5	5	10	5	
41	49	32	48	40	
+	+	+	+	+	V
.	+	.	.	.	III
.	+	+	.	.	II
.	1	2	.	.	II
.	.	.	.	.	II
+	.	.	.	.	II
.	.	.	.	.	II
+	.	.	.	.	II
+	.	.	.	.	II
.	.	.	.	.	II
.	+	.	.	.	I
.	.	.	.	.	I
.	.	.	.	.	I
1	.	.	.	.	I
.	.	.	.	.	I
.	.	.	.	.	II
.	.	.	.	.	II
.	.	.	.	.	II
.	.	.	.	.	I
.	.	.	.	.	II
.	.	.	.	.	II
.	.	.	.	.	II
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.	.	.	.	.	II
.	.	.	.	.	I
.	.	.	.	.	I
.	.	.	.	.	I
.	.	.	.	.	I
+	1	.	+	.	IV
+	+	+	.	+	IV
.	+	.	.	.	IV
.	+	+	+	.	IV
.	.	.	.	.	II
+	.	.	.	.	II
.	.	+	+	.	I
2	3	3	4	3	V
+	+	+	.	+	III
.	+	+	.	.	III
+	+	+	.	.	II
+	.	+	.	.	II
.	+	.	.	+	II
.	.	+	.	.	II
.	.	.	.	.	II
.	.	.	.	+	II
.	.	.	+	+	II
.	+	.	.	2	I
.	.	.	.	.	I
2	2	4	3	4	V
+	1	.	+	1	III
+	+	+	+	+	III
+	+	.	.	+	II
.	+	.	+	.	II
.	+	+	.	.	II
.	+	1	.	.	I

(Petitmengin 1904); var. *iranica* (Azerbaijan, Armenia, N Iran) (Tzvelev 1957; Novopokrovskij & Tzvelev 1958), and var. *heraclei* on *Heracleum* sp. (Greater Caucasus) (Tzvelev 1957; Novopokrovskij & Tzvelev 1958). They require a taxonomic revision and target studies on preferred hosts. Forms distinguished on the basis of the length of calyx teeth and bracts have also been described: *O. alsatica* var. *typica* G. Beck f. *haplodous* G. Beck, f. *genuina* G. Beck, and f. *macrosepala* (F. Schultz) G. Beck (Beck 1930).

The complex of taxa included in *O. alsatica* agg. requires further field investigations and detailed taxonomic revisions within its entire range using up-to-date methods, including molecular investigations (Piwowarczyk mscr.). Micromorphological SEM studies have shown that there are considerable differences in seed and pollen ornamentation between *O. alsatica*, *O. bartlingii*, and *O. mayeri* (Piwowarczyk *et al.* mscr.).

3.2. Distribution in Poland

Orobanche alsatica in Poland is known from 17 localities, mostly discovered in the last 5 years, and 14 of them persist. The list below provides only verified data, due to frequent determination errors. The species was recorded in the East Pomeranian Lakeland (Pojezierze Wschodniopomorskie) in the past (Abromeit *et al.* 1898; Scholz 1905). At present it also grows in the Silesia-Kraków Upland (Wyżyna Śląsko-Krakowska) (Ł. Krajewski, unpubl.), Małopolska Upland (Wyżyna Małopolska) (Piwowarczyk 2012b), Lublin Upland (Wyżyna Lubelska), Roztocze, and Polesie (Piwowarczyk *et al.* 2011) (Fig. 1; Appendix).

3.3. Preferred habitats and plant communities in Poland

Orobanche alsatica in Poland prefers xerothermic fringe (forest edge) communities of the alliance *Geranion sanguinei* in the spatial complex of thermophilous oak forests *Potentillo albae-Quercetum* and thickets, especially of the alliances *Berberidion* and *Prunion fruticosae*, and xerothermic grasslands of the alliance *Cirsio-Brachypodion pinnati*. It grows in xerothermic oak forests of the association *Potentillo albae-Quercetum*, occurring mostly on hillsides, in erosion channels, less frequently in flat areas. A specific combination of species, i.e. calcicolous, helio- and thermophilous, mesotrophic, and moderately acidophilous, is observed in the species’ habitats in such forests. These are mosaics of forest patches and herbaceous fringe communities and grasslands (formerly reported as *Peucedano cervariae-Coryletum*). Therefore these communities

Table 1. Cont.

No. of relevé	1	2	3	4	5	6	7	8
Location	Korzecko	Zabłoty Mt 1	Zabłoty Mt 2	Zabłoty Mt 3	Orłów Murowany	Wolwinów	Horeszkowice	Łabunie
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Altitude a.s.l. [m]	315	323	282	287	240	200	210	240
Area of relevé (m^2)	25	25	25	25	20	25	50	50
Exposure	S	SW	S	S	S	SE	SSE	N
Inclination [°]	15	15	10	10	15	5	5	5
Cover of tree layer A (%)	50	40	50	60	20	20	30	80
Cover of shrub layer B (%)	15	30	15	30	30	60	20	15
Cover of herbaceus layer C (%)	90	75	80	95	60	75	95	100
Cover of moss layer D (%)	5	5	5	5	>5	>5	>5	15
Number of species	35	30	42	39	21	27	43	46
Helianthemum nummularium	.	.	.	.	.	.	.	.
Thesium linophyllon	.	.	.	.	.	.	.	.
Dianthus carthusianorum	.	.	.	.	.	.	.	.
Phleum phleoides	.	.	.	.	.	.	.	.
Veronica spicata	.	.	.	.	.	.	.	.
Campanula sibirica	.	.	.	.	.	.	.	.
Asperula tinctoria	.	.	+	.	.	.	.	.
ChCl. *Rhamno-Prunetea*								
Cornus sanguinea B	.	3	1	2	+	.	.	+
Cornus sanguinea C	.	3	.	1	+	.	+	3
Prunus spinosa B	.	.	.	.	.	3	.	.
Prunus spinosa C	.	.	.	.	.	2	+	.
Viburnum opulus C	.	.	.	.	+	.	.	+
Rhamnus cathartica B	.	.	.	+	.	.	.	.
Crataegus monogyna C	+	.	+	.	.	.	.	+
Cerasus fruticosa C	.	.	.	.	.	1	.	.
ChCl. *Molinio-Arrhenatheretea*								
Galium mollugo	.	.	.	.	.	+	+	.
Betonica officinalis	.	+	.	.	.	.	+	.
Leucanthemum vulgare	.	.	.	.	.	.	+	+
Inula salicina	.	+	.	.	.	2	+	.
Dactylis glomerata	.	.	.	.	.	+	1	.
Achillea millefolium	.	.	.	+	.	.	.	.
Knautia arvensis	.	.	.	.	.	+	+	.
Festuca rubra	.	.	.	.	.	.	.	.
Agrostis gigantea	.	.	.	.	.	.	.	.
Arrhenatherum elatius	.	.	.	.	.	.	.	+
Lotus corniculatus	.	.	.	.	.	.	.	.
Tragopogon orientalis	.	.	.	.	.	.	.	.
Valeriana officinalis	.	.	.	.	.	.	+	.
Others								
Pinus sylvestris A	+	1	r	.	1	.	.	2
Quercus robur C	+	+	.	.	.	+	+	+
Quercus robur A	4	2	4	4	.	.	.	.
Quercus robur B	1	.	+	.	.	1	.	1
Carex flacca	.	.	.	.	.	.	.	.
Fragaria vesca	.	+	+	+	.	.	.	+
Primula veris	.	.	.	.	.	.	.	+
Calamagrostis epigejos	.	.	.	.	.	1	+	.
Pteridium aquilinum	.	.	.	.	+	.	.	.
Rosa sp. C	.	.	.	.	.	+	.	.
Rubus caesius	.	.	.	.	.	.	+	.
Festuca ovina	.	+	+	+	.	.	.	.
Juniperus communis C	.	.	+	.	.	.	.	+
Prunella grandiflora	.	.	.	.	.	.	.	+
Rubus sp.	.	+	+	+	.	.	.	.
Salvia pratensis	.	.	.	.	.	.	+	.
Thymus pulegioides	.	.	.	.	.	.	.	.
Vincetoxicum hirundinaria	1	.	+	+	.	.	.	.
Frangula alnus B	1	.	.	.	.	.	.	.
Lembotropis nigricans	+	.	.	.	.	.	.	.
Juniperus communis B	.	.	+	.	.	.	.	.
Ajuga reptans	+	.	.	.	.	.	.	.
Artemisia vulgaris	.	.	.	.	.	.	.	+
Briza media	.	.	.	.	.	.	+	.
Euphorbia angulata	.	.	.	.	.	.	+	.
Hypericum perforatum	.	.	.	.	.	.	.	+
Medicago lupulina	.	.	.	.	+	.	.	.
Sanguisorba minor	.	.	.	.	.	.	.	.

9	10	11	12	13	
Kąty	Broczówka	Biała Mt.	Grabina Mt.	Jaworzno NE	
13.07.2008	13.07.2008	28.06.2008	15.06.2009	13.08.2010	
50°40’33”	50°52’05”	50°28’33”	50°52’22,3”	50°12’13”	C
23°07’22”	23°22’05”	23°28’44”	20°34’40,2”	19°23’39”	o
280	240	330	302	330	n
25	50	25	25	25	s
S	SW	SSW	S	N	t
15	20	20	10	15	a
30	20	10	-	-	n
40	40	20	-	-	c
95	100	95	95	100	y
10	5	5	10	5	
41	49	32	48	40	
.	.	.	1	+	I
1	+	.	.	.	I
.	.	.	+	+	I
.	.	.	+	+	I
.	.	.	+	+	I
.	.	+	+	.	I
.	+	.	.	.	I
.	.	+	.	.	III
+	.	.	.	+	III
+	+	.	.	.	II
+	.	.	+	.	II
+	+	.	.	.	II
+	.	+	.	.	II
.	.	.	.	+	II
.	+	.	.	.	I
.	.	1	+	1	II
.	+	.	.	+	II
.	+	.	.	+	II
.	.	.	.	.	II
.	.	.	+	.	II
.	.	.	+	+	II
.	+	.	.	.	II
.	.	.	1	2	I
.	.	.	+	+	I
.	.	.	+	.	I
.	.	.	+	+	I
+	+	.	.	.	I
.	+	.	.	.	I
2	.	1	.	.	III
+	+	.	.	.	III
.	.	.	.	.	II
.	+	.	.	.	II
+	1	+	.	+	II
.	.	.	.	.	II
+	+	.	.	+	II
.	.	.	+	.	II
.	.	.	3	+	II
.	+	.	1	.	II
.	.	.	1	2	II
.	.	.	.	.	II
.	+	.	.	.	II
.	+	.	.	+	II
.	.	.	.	.	II
.	+	+	.	.	II
.	+	.	+	+	II
.	.	+	.	.	II
1	+	.	.	.	II
.	+	1	.	.	II
.	2	.	.	.	I
+	.	.	.	.	I
.	.	.	+	.	I
.	.	.	.	+	I
+	.	.	.	.	I
+	.	.	.	.	I
.	.	.	+	.	I
+	.	.	+	.	I

strongly resemble those of the classes *Trifolio-Geranietea sanguinei*, *Festuco-Brometea*, and *Rhamno-Prunetea*. These plant communities occur on brown, sandy-loamy or loess soils, on a shallow deposit of calcareous rocks. These soils are usually rich in calcium carbonate, such as rendzinas, para-rendzinas or brown soil, on warm, usually southern slopes. It is extremely difficult to distinguish in these communities species common to both the *Potentillo albae-Quercetum* and phytocoenoses of the class *Trifolio-Geranietea*. *O. alsatica* mostly occurs in thermophilous forests: on glades, logging sites, clearings, top parts of uplands, by forest paths, on forest margins, in secondary forest-steppe complexes, and in ecotone communities of the alliance *Geranion sanguinei*. These are distinctly xerothermic fringe communities in a spatial complex of thermophilous oak forests and thickets, especially of the alliances *Berberidion* and *Prunion fruticosae*. Such systems in thermophilous forest complexes have been observed in the Grzywy Korzeckowskie (part of the Świętokrzyskie Mts.), on Zabłoty Mt., near Horeszkowice, Orłów Murowany, Łabunie, and Wolwinów. The species is noted less frequently in

Sporadic: **ChCl. *Querco-Fagetea*, ChO. *Fagetalia sylvaticae*:** *Acer platanoides* A 6(2), *A. pseudoplatanus* B 9, *Actaea spicata* 9, *Asarum europaeum* 8, *Cephalanthera damasonium* 1, *C. rubra* 1(r), *Circaea lutetiana* 8, *Cruciata glabra* 8, *Cypripedium calceolus* 9, *Fagus sylvatica* C 10, *Fraxinus excelsior* A 8(4), *Galeobdolon luteum* 5, *Galium odoratum* 8, *Neottia nidus-avis* 1, *Padus avium* A 10(2) B 9, *Sanicula europaea* 8; **ChCl. *Trifolio-Geranietea sanguinei*:** *Lathyrus sylvestris* 12, *Verbascum lychnitis* 12, *Vicia pisiformis* 1; **ChAll. *Geranion sanguinei*:** *Fragaria viridis* 12, *Thalictrum minus* 6, *Veronica teucrium* 6; **ChCl. *Festuco-Brometea*:** *Artemisia campestris* 12, *Asperula cynanchica* 13, *Bromus benekenii* 8, *Carex humilis* 10, *Filipendula vulgaris* 13, *Onobrychis viciifolia* 11, *Plantago media* 12, *Poa compressa* 4; **ChO. *Festucetalia valesiacae*:** *Hieracium bauhinii* 11, *Potentilla arenaria* 12, *Scabiosa ochroleuca* 13; **ChAll. *Cirsio-Brachypodion pinnati*:** *Allium montanum* 4, *Aster amellus* 10, *Cirsium pannonicum* 10(1), *Inula ensifolia* 10(2), *Linum flavum* 11(2), *Seseli annuum* 12, *Melampyrum arvense* 11(1); **ChCl. *Rhamno-Prunetea*:** *Cerasus fruticosa* B 6(2), *Crataegus monogyna* B 7, *Rhamnus cathartica* C 9, *Viburnum opulus* B 10; **ChCl. *Molinio-Arrhenatheretea*:** *Anthyllis vulneraria* 10, *Carex tomentosa* 7, *Centaurea jacea* 13, *Phleum pratense* 7, *Plantago lanceolata* 12, *Prunella vulgaris* 12, *Tragopogon pratensis* 11, *Trifolium montanum* 13, *T. repens* 12; **Others:** *Arnica montana* 8, *Betula pendula* A 2(2), *Carlina acaulis* 13, *C. intermedia* 9, *Cimicifuga europaea* 7(1), *Cirsium arvense* 7, *Conyza canadensis* 2, *Chamaecytisus ratisbonensis* 10, *Ch. ruthenicus* 9, *Epilobium* sp. 2, *Erigeron acer* 12, *Euphorbia esula* 12, *Frangula alnus* C 10, *Genista tinctoria* 12, *Geranium sylvaticum* 7, *Gymnadenia conopsea* 8, *Hieracium murorum* 2, *H. umbellatum* 3, *Larix decidua* A 7(1), B(1), C, *Maianthemum bifolium* 8, *Malus sylvestris* A 9, *Melampyrum pratense* 11, *Ononis arvensis* 10, *O. spinosa* 13, *Orobanche lutea* 11, *Peucedanum alsaticum* 9, *Platanthera chlorantha* 8, *Poa annua* 12, *Polygala vulgaris* 12, *Populus tremula* B, C 6, *Pyrus pyraster* A 6, 7, *Ranunculus bulbosus* 12, *Rhinanthus serotinus* 13, *Robinia pseudoacacia* C 9, *Rosa* sp. B 10, *Rubus saxatilis* 9, *Sedum maximum* 4, *Sorbus aucuparia* B 9, *Tanacetum corymbosum* subsp. *corymbosum* 10, *Vaccinium myrtillus* 3, *Veratrum lobelianum* cfr. 7, *Verbascum nigrum* 10, *Veronica chamaedrys* 12, *Viola collina* 2, *V. riviniana* 8

open grasslands, on warm, usually southern hillsides and slopes of erosion gullies, in communities of the alliances *Geranion sanguinei* and *Cirsio-Brachypodion pinnati*, e.g. near Jaworzno NE, Kąty II, Grabina Mt., Biała Mt., Broczówka (Table 1).

4. Discussion

The ranges of *Orobanche alsatica* and *O. bartlingii* require further investigations. It seems, however, that although they are similar, *O. bartlingii* is probably more frequent in the Baltic states and Russia to Siberia (Kreutz 1995). Recently it has also been recorded in the Pyrenees at 1200-1700 m (Carlón *et al.* 2009). Unlike *O. alsatica*, which prefers warmer regions and usually relatively low-altitude areas, *O. bartlingii* is often recorded at colder, lowland sites and also submontane and montane areas with considerable temperature fluctuations, also having colder exposures (Nieschalk & Nieschalk 1974; Kreutz 1995; Carlón *et al.* 2009). The distribution range of *O. mayeri* is small: usually single localities in Germany (Swabian Alb), Slovakia (mostly in the Low Tatras, Nízke Tatry Mts.) and Poland (Pieniny Mts.). It is noted in submontane and montane areas, in montane grasslands, at 650-1000 m on average (max. 1500 m) (Süssenguth & Ronniger 1942; Zázvorka 1997; Piwowarczyk 2011a).

Species of the series *Alsaticae* in Poland differ in preferred habitats, plant communities, hosts, regional distribution (Figs. 1-2), and altitudinal range. *Orobanche alsatica* prefers thermophilous fringe vegetation of the alliance *Geranion sanguinei*, often forming a mosaic with thermophilous oak forests (*Potentillo albae-Quercetum*) and xerothermic grasslands, noted less frequently in open xerothermic grasslands of the alliance *Cirsio-Brachypodion pinnati*, at 210-345 m. Most of its localities are in SE Poland: the Lublin Upland, Roztocze, and Polesie, rarely in the Małopolska and Silesia-Kraków Uplands (Fig. 1). The number of individuals at the localities ranges from one to over 200 shoots and varies between years. Local populations consisting of 1 to 15 shoots are in Zawarpie, Grzywy

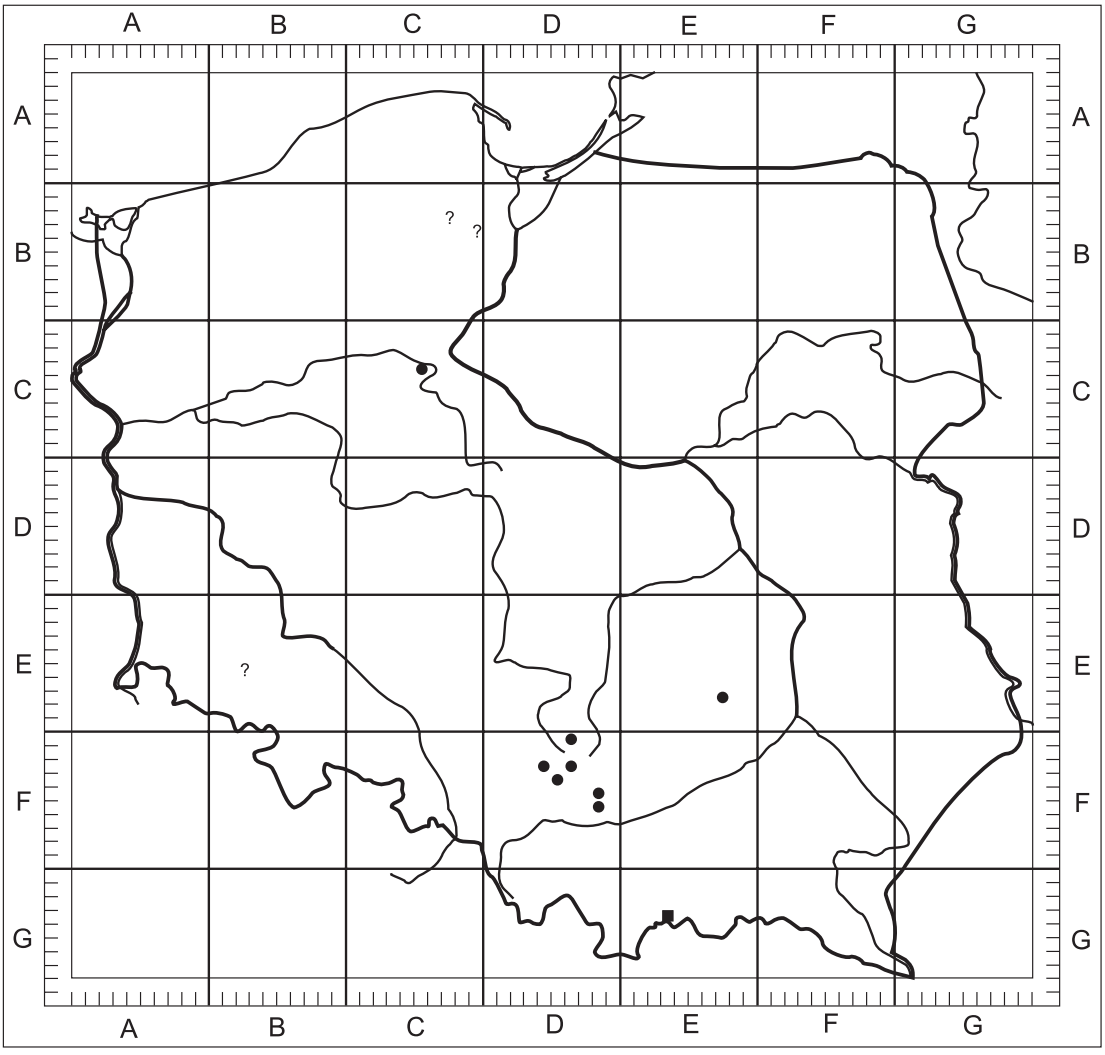

Fig. 2. Distribution of *Orobanche bartlingii* (●) and *O. mayeri* (■) in Poland
Explanation: ? – literature data, difficult to differentiate

Korzeckowskie, Orłów Murowany, Wolwinów, and on Zabłoty Mt. From 20 to over 50 shoots were found on Grabina Mt., Wieprzecka Mt., Biała Mt., in Łabunie, Jaworzno-Długoszyn, Czechówka, and Horeszkowice. The largest populations, comprising over 100 to over 200 shoots, are in Broczówka and Jaworzno NE (Piwowarczyk *et al*. 2011; Piwowarczyk 2012a, 2012b; Krajewski Ł. unpubl.).

Orobanche bartlingii prefers thermophilous fringe vegetation and thickets of the alliances *Geranion sanguinei* and *Prunion spinosae*, often forming a mosaic with xerothermic grasslands of the order *Festucetalia valesiacae*, usually with the saxicolous association *Festucetum pallentis*. These communities usually form a mosaic on calcareous monadnocks or rocky slopes of river valleys or wastelands and abandoned fields, mostly in the Polish Jura i.e. the Kraków-Częstochowa Upland (Wyżyna Krakowsko-Częstochowska), the Silesian Upland (Wyżyna Śląska), sporadically in the Świętokrzyskie Mts. (Szeląg 2001a, 2001b; Rakowski 2004; Piwowarczyk *et al*. 2009; Nowak-Dańda & Dańda 2006; Piwowarczyk 2011b; Krajewski 2011) and recently discovered in N Poland in the valley of the Noteć river (Korczyńska-Krasicka, unpubl. 2000-2011) (Fig. 2). It is noted at altitudes of (65) 265-490, usually above 300 m. As well as occurring at S-facing sites, it is often recorded at N-facing exposures. Studies to date indicate that of the 3 species, *O. bartlingii* is the most tolerant of and even prefers colder, not sun-exposed places. The size of local populations is usually very high, from 100 to a few thousand shoots.

Orobanche mayeri grows in the Pieniny Mts. (Fig. 2) in calcareous high montane grasslands of the class *Seslerietea variae*, with a high contribution of species of the classes *Festuco-Brometea*, *Trifolio-Geranietea sanguinei* and *Querco-Fagetea*, at altitudes of 725-967 m. Its local populations consist of 5-30 shoots and their size fluctuates annually; the species is not recorded every year (Piwowarczyk 2011a).

Detailed research into preferred hosts in 2006-2011 and soil test pits have shown that in Poland *Orobanche alsatica* is parasitic only on *Peucedanum cervaria*, *O. bartlingii* on *Libanotis pyrenaica*, and *O. mayeri* on *Laserpitium latifolium*. Another host of *O. mayeri* reported by Zázvorka (1997), *Pimpinella major* subsp. *rhodochlamys* in the Ohnište massif in the Low Tatra Mts. at 1512 m, was confirmed by me in 2011.

Threats and protection recommendations for *Orobanche bartlingii* and *O. mayeri* are discussed elsewhere (Piwowarczyk 2011a, 2011b, 2012c; Piwowarczyk *et al*. 2009). Due to the small size of *O. alsatica* populations, considerable scattering of the localities and the species' occurrence at transient and specific thermophilous thicket communities, often within thermophilous oak forests or xerothermic grasslands, it is mostly threatened by secondary succession or inadequate forest management. Systematic observations are necessary and when the density of the shrub layer or herbaceous vegetation is excessive, periodic mowing may be recommended. Forest stands can also be gradually restructured and pasturage should be limited. It is also recommended to preserve an appropriate structure of patches of the thermophilous oak forest and thermophilous fringe vegetation, including the mosaic pattern of communities. At present, 3 localities of *O. alsatica* are protected as part of nature reserves and one as an ecological site (Polish: *użytek ekologiczny*). Active protection measures should be encouraged and carried out at other localities. *O. alsatica* should be included in a nature monitoring programme.

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Appendix. List of localities of *Orobanche alsatica*

CB: 29 – Żabno (Scholz 1905); **CF: 16** – Gogolin, cfr., leg. Dziatzko, 21.07.1897 (OPOL, P/3452); **DB: 51** – nature reserve Wiosło Duże, (Kwidzyn: Schlucht hinter, Gr. Wessel) leg. Bünau, 07.07.1893, 18.06.1895 (TRN, 463; with *Peucedanum cervaria*), (Münsterwalder Forst, Gr. Wessel-Kozelec), leg. Scholz, 20.06.1897 (TRN, 1263; with *P. cervaria*), 15.07.1899 (W, 1673); Abromeit *et al.* 1898 [after Klinggräff 1874: Königliches Forst-Revier, Krausenhof (Münsterwalder Forst) and Scholz 1898: Schonung S. Gr.-Wessel); Ascherson & Graebner 1899 (Kozielecer Gutswald bei Gr. Wessel); **DF: 24** – Zawarpie near Siewierz, a clearing on soil mounds, E-facing slope, 345 m, (10), vid. Krajewski Ł., 2009-2010; **44** – Jaworzno, Długoszyn W, S-, SW-facing slope, (50), vid. Krajewski Ł., 2010; **55** – Jaworzno NE, hills W of Trzebinia-Stara Maszyna, N-, NW-facing slopes, (200), vid. Krajewski Ł., 2010; **EE: 71** – Zabłoty Mt. near Małogoszcz, xerothermic oak forest between Skorków and Wrzosówka, forest sect. 11, SW-facing (<15), 50°51°23.1"N, 20°14'44.6"E, 282-323, leg. A. Adamiec, 2008, leg. R. Piwowarczyk, 30.07.2008 (KTC); **73** – Grabina Mt. near Kielce, S-, SE-facing slopes; xerothermic grasslands and thermophilous thickets, in former excavation pits (<50), 50°52'22.3"N, 20°34'40.2"E, 302 m, vid. A. Konopacki, 2008, leg. R. Piwowarczyk, 15.06.2009, 28.06.2010 (KTC); **82** – Grzywy Korzeckowskie near Korzecko, xerothermic oak forest, forest sect. 188, 1 specimen in 2007, absent in 2008, 50°47'42"N, 20°24'11"E, 315 m, vid. M. Fałdziński, R. Piwowarczyk, 09.08.2007; **GE: 34** – nature reserve Wolwinów, by Hrubieszów–Chełm road (oak forest thickets on a chalky substrate, leg. Fijałkowski D., 24.06.1958, LBL). One specimen was recorded in 2007, 51°06'59"N, 23°30'49"E, vid. R. Piwowarczyk, P. Chmielewski, 08.06.2007 (KTC), Piwowarczyk *et al.* 2011; **56** – ca. 3 km SE of Horeszkowice – a midforest glade in a vast forest complex (Lasy Strzeleckie), in oak-hornbeam and swamp forests (<30), 50°56'21"N, 23°49'28"E, leg. J. Wójciak, R. Piwowarczyk, 12.07.2008 (KTC), Piwowarczyk *et al.* 2011; **62** – ca. 1 km E of Orłów Murowany – forest complex, on a slope of a calcareous hill (<10), 50°54'26"N, 23°14'26", leg. P. Chmielewski, R. Piwowarczyk, 11.07.2008 (KTC), Piwowarczyk *et al.* 2011; **63** – nature reserve Broczówka, ca. 1.5 km N of Skierbieszów, SW-facing slopes, xerothermic grasslands and thickets (<100), 50°52'05"N, 23°22'05"E, leg. R. Piwowarczyk, W. Michalczuk, P. Chmielewski, 08.06.2005 (KTC), leg. A. Cwener, 2006 (LBL), leg. R. Piwowarczyk, 15.07.2006 (KTC), Piwowarczyk *et al.* 2011; **64** – Czechówka, a partly overgrown xerothermic grassland and shrub communities on a glade in a forest complex by Grabowiec-Wojsławice road (<50), 50°51'17"N, 23°32'08"E, leg. A. Cwener, 02.07.2006, (LBL), Piwowarczyk *et al.* 2011; **82** – Kąty II, a midfield hill known as Wieprzecka Mt., in xerothermic thickets (<20), 50°40'33"N, 23°07'22"E, leg. R. Piwowarczyk, W. Michalczuk, P. Chmielewski, 13.07.2006 (KTC), Piwowarczyk *et al.* 2011; **94** – nature reserve Łabunie, on a glade at forest edge, ca. 1 km SE of village buildings, thermophilous thickets in thermophilous oak forest (<30), 50°39'10"N, 23°24'56"E, leg. Fijałkowski D., 06.07.1951, 15.07.1956, 22.06.1957 (LBL), leg. P. Chmielewski, R. Piwowarczyk, 12.07.2007, 13.07.2008 (KTC), Piwowarczyk *et al.* 2011; **GF: 14** – Biała Mt. ecological site, between Majdan Górny and Justynówka villages, on a S- and SW-facing vast calcareous slope, xerothermic grasslands and thickets (<50), 50°28'33"N, 23°28'44"E, leg. P. Chmielewski, R. Piwowarczyk, 13.07.2006 (KTC), leg. R. Piwowarczyk, 28.06.2008 (KTC), Piwowarczyk *et al*. 2011.

Erroneous records: AC30 – nature reserve Bielinek (Celiński & Filipek 1958), mistaken with *O. elatior*; **CB: 27** – Bożepole Szlacheckie, Dolne Maliki (Buliński 1993, 1994), Buliński reports *Libanotis pyrenaica* as the host, which suggests it was *O. bartlingii*; **39** – Nowa Wieś Rzeczna (in Starogard Gdański on a hill towards Nowa Wieś Rzeczna near a powder magazine) [bei Pr.-Stargard am Ferseabhang: Weg nach Neuendorf am Pulverschuppen vorbei auf *L. montana*] (Abromeit *et al.* 1898, after Gross 1897); Pr. Stargard: Saubener Schweiz (Ascherson & Graebner 1898/1899 after Gross PÖG. Königsb. 38. 70), most probably the report concerns *O. bartlingii*; **BE: 52** – Grobla (Schube 1929, 1930; Limpricht 1944), the reports most probably concern *O. bartlingii*, as those authors report *L. pyrenaica* as the host (Kwiatkowski 2006). *Orobanche alsatica* was not recorded during my investigations at the site in 2011, but *L. pyrenaica* individuals were observed at potential localities; **CF: 65** – Gipsowa Mt., Dzierżysław near Kietrz (Fiek 1881; Schube 1903; Beck 1930), mistaken with *O. elatior*, which is indicated by herbarium materials and my field investigations; **CF: 67** – Racibórz (Podpéra, Kvét. Moravy, ATPOL data); **DF: 35** – Wielka Mt. near Strzemieszyce Małe (Babczyńska-Sendek 2005), mistaken with *O. bartlingii*, verified in the field by Babczyńska-Sendek and myself in 2007. The correction is available in a study by Babczyńska-Sendek (2009); **DF: 48** – near Grodzisko in the Ojców National Park (Michalik 1978), *O. alsatica* agg. in Zając & Zając (2001), Zając *et al*. (2006) concerns *O. bartlingii* (Szeląg 2001a,b); **FE: 13** – Bochotnica, **23** – Janowiec, Podgórz, **52** – Dorotka, Ciszyca Górna (Kucharczyk unpubl. 1996, 1999, ATPOL database; Kucharczyk 2001), based on the herbarium material available and field investigations, only other species of the genus *Orobanche*, e.g. *O. caryophyllacea* and *O. lutea*, were recorded at those localities.

Erroneously positioned localities: Localities at Widlice or Kwidzyn (Beck 1930) most probably describe one locality: the Wiosło Duże reserve; Faix-Blösse, leg. B. Kotula, 02.08.1885 (W, 12952) after Pujadas and Gómez (2000) is not in Poland but in the Belianske Tatra Mts. (Faixová lúka) in Slovakia; Münsterwalder Forst bei Koszelitz, Scholz 15.07.1899 (W, 1673) after Pujadas and Gómez, 2000, is not in Austria but in Poland (cf. "List of localities").

Remark: Specimens in Polish collections document some of the localities of *Orobanche alsatica* in Ukraine: on the S and SW margins of a beech-pine forest in Horodysk in *Caricetum humilis*, Zahorodysko near Sassów (now Sasiv), leg. J. Mądalski, 01.09.1936 (KRAM, 494730); on the S sunny chalky slope of the NE arm of Łysówka hill, Winniki (now Vynnyky) near Lviv, leg. J. Mądalski, 25.07.1938 (KRAM, 494727), on *P. cervaria*.