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The genus *Orobanche* L. (Orobanchaceae) in the Małopolska Upland (S Poland): distribution, habitat, host preferences, and taxonomic problems

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Abstract: The paper presents the distribution of *Orobanche* species (parasitic herbs known as broomrapes) in the Małopolska Upland (Wyżyna Małopolska) in southern Poland. During floristic research conducted there in 1999-2011, 12 species of this genus were recorded: *O. alba, O. alsatica, O. arenaria, O. bartlingii, O. caryophyllacea, O. coerulescens, O. elatior* s.str., *O. kochii, O. lutea, O. pallidiflora, O. picridis* and *O. ramosa*. Eight species were not previously known from this area. Information on the hosts, abundance, and habitat preferences at the localities is given, and an updated map of the distribution in the Małopolska Upland is included. The taxonomic position of *O. elatior* s.str. and *O. kochii,* diagnostic features to differentiate between them, and a revised map of distribution of both species in Poland are also presented.

Key words: *Orobanche*, *Orobanche elatior*, *Orobanche kochii,* distribution, habitat, host, Małopolska Upland, Poland

1. Introduction

The family Orobanchaceae contains 15 genera with 250 herbaceous species. *Orobanche* is the largest genus and comprises approximately 200 species (over 30 from Central Europe) that lack chlorophyll and are holoparasites of other vascular plants (Uhlich *et al.* 1995; Pusch & Günther 2009). In Europe they usually grow in the warmest regions, mostly in the Mediterranean region. The majority of species, both in Poland and generally in Europe, are rare and threatened with extinction. Eleven species are included in the red list of plants in Poland (Zarzycki & Szeląg 2006), 2 in the Polish red data book of plants (Kaźmierczakowa & Zarzycki 2001), and 8 in the new edition of this book (Kaźmierczakowa & Zarzycki 2012).

Nineteen species of the genus *Orobanche* have been reported from Poland. Until recently, these included the native or naturalized *O. alba, O. alsatica, O. arenaria, O. bartlingii, O. caryophyllacea, O. coerulescens, O. flava, O. lutea, O. minor, O. pallidiflora, O. picridis, O. purpurea,* probably archaeophyte *O. ramosa*, as well as 2 ephemerophytes: *O. hederae* and *O. lucorum* (e.g. Mądalski 1967; Zając & Zając 2001; Halamski 2005; Nejfeld & Bartoszek 2008; Piwowarczyk 2012a, 2012b, 2012c; Piwowarczyk & Przemyski 2009, 2010; Piwowarczyk *et al.* 2009, 2010, 2011). Lately, 2 new species, *O. mayeri* (Piwowarczyk 2011a) and *O. bohemica* (Piwowarczyk 2012a), have been discovered, and *O. elatior* and *O. kochii* have been separated. By contrast, data on the occurrence of *O. gracilis* (Mądalski 1967) and *O. teucrii* (Zarzycki 1981 after Jasiewicz oral. comm.) in Poland are erroneous. The verified herbarium material and my field investigations have confirmed that those records concerned *O. caryophyllacea* in fact.

Published data on the occurrence of the genus *Orobanche* in the Małopolska Upland were scarce and usually described single localities or individual species, with only very general information on the location given (e.g. Hempel 1885; Błoński 1892; Dziubałtowski 1916, 1922; Szafer 1918; Kozłowska 1923; Błaszczyk 1959; Tacik 1959; Mądalski 1967; Głazek 1968a, 1968b, 1976; Wnuk 1978; Cieśliński 1981; Szwagrzyk 1987; Bróż 1988; Bróż & Przemyski 1989; Głazek & Łuszczyńska 1994; Szeląg 1997; Towpasz & Trzcińska-Tacik 1997; Łuszczyńska 1998, 2000; Przemyski & Stachurski 1999; Kucharczyk 2001; Towpasz 2006; Zając *et al.* 2006; Nobis 2007; Wnuk & Pisarek 2008;

Binkiewicz 2009; Nobis & Nobis 2010; Przemyski *et al*. 2010). *Orobanche* species were often misidentified and the lack of herbarium materials frequently made verification impossible, so it was necessary to verify the species in the field in such cases.

The aim of my study was to identify the distribution of species of the genus *Orobanche* in the Małopolska Upland, based on my investigations and verified herbarium and literature data. The preferred habitats, communities, hosts, and taxonomic problems are also discussed below. Additionally, *O. elatior* and *O. kochii* are separated here for the first time, and preliminary maps of their distribution in Poland are included. This is the first study to present a verified and detailed distribution of the genus in the Małopolska Upland. I recorded many new localities of 12 species of the genus *Orobanche* during floristic research in this region between 1999 and 2011.

2. Materials and methods

2.1. Study area

The Małopolska Upland (Wyżyna Małopolska) is a physical-geographic upland subprovince in southern Poland and forms the central part of Polish Uplands (Wyżyny Polskie). It is located west of the middle section of the Vistula river. The Małopolska Upland covers 16.7 thousand km^2, i.e. 5.3% of Poland. It extends from the Vistula valley between Kraków and Sandomierz, towards Radom and Tomaszów Mazowiecki in the north, and near Częstochowa in the west (Fig. 1). It forms a descending tectonic-erosion scarp towards Subcarpathian basins in the south and a dense deposit of Saalian Stage formations in the north. Three different geographic units (macroregions) are distinguished within the Małopolska Upland: the Przedbórz Upland (Wyżyna Przedborska), Nida Basin (Niecka Nidziańska), and Kielce Upland (Wyżyna Kielecka) (Kondracki 2001, Fig. 1).

The geological structure and land relief in the Małopolska Upland are diversified. The upland consists of hills and depressions formed by Cretaceous, Jurassic, and Tertiary rocks. Limestone, resulting from marine transgression, forms the southern part, with a thick loess layer deposited on it. Karst processes are observed here, with gypsum karst in the Nida Basin being especially interesting. The northern part is covered by Quaternary formations (sands and clays). Elevations of 200-300 m above sea level dominate, and culminations exceed 600 m only in the Świętokrzyskie Mts.

The climate of the Małopolska Upland is within 2 agroclimatic districts: the Częstochowa-Kielce dis-

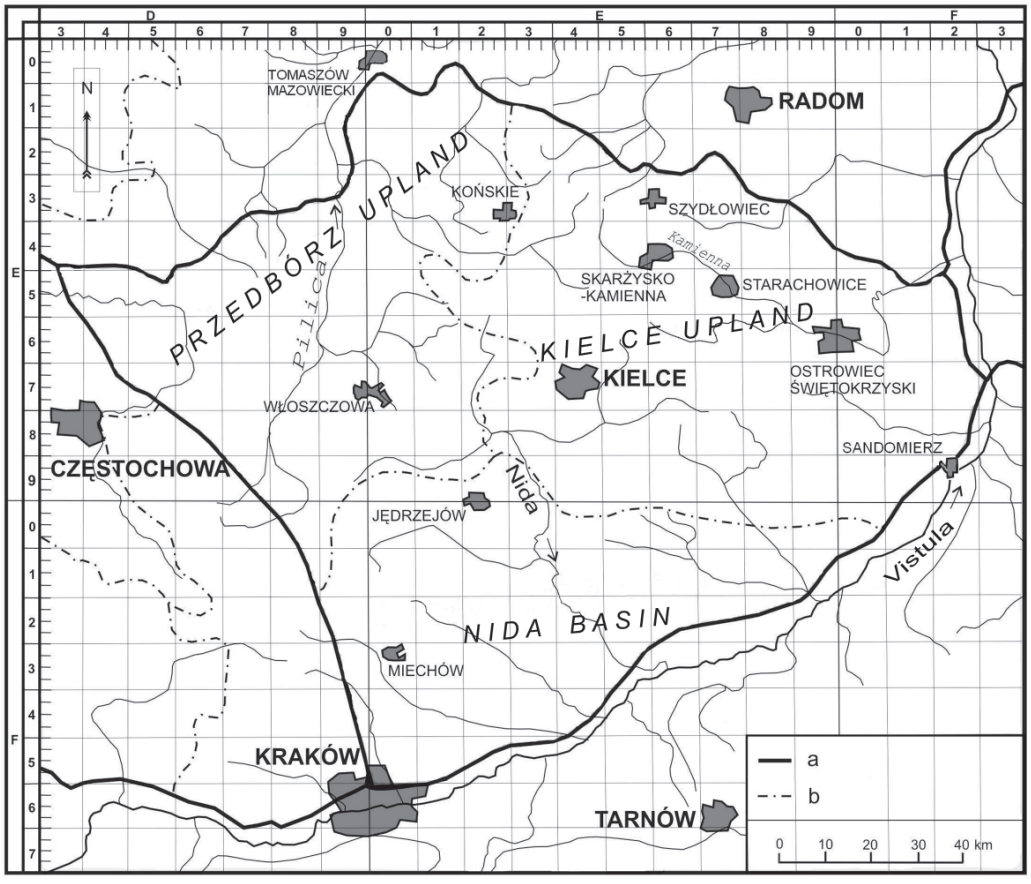

Fig. 1. Location of the study area
Explanations: a – borders of the Małopolska Upland, b – borders of the macroregions

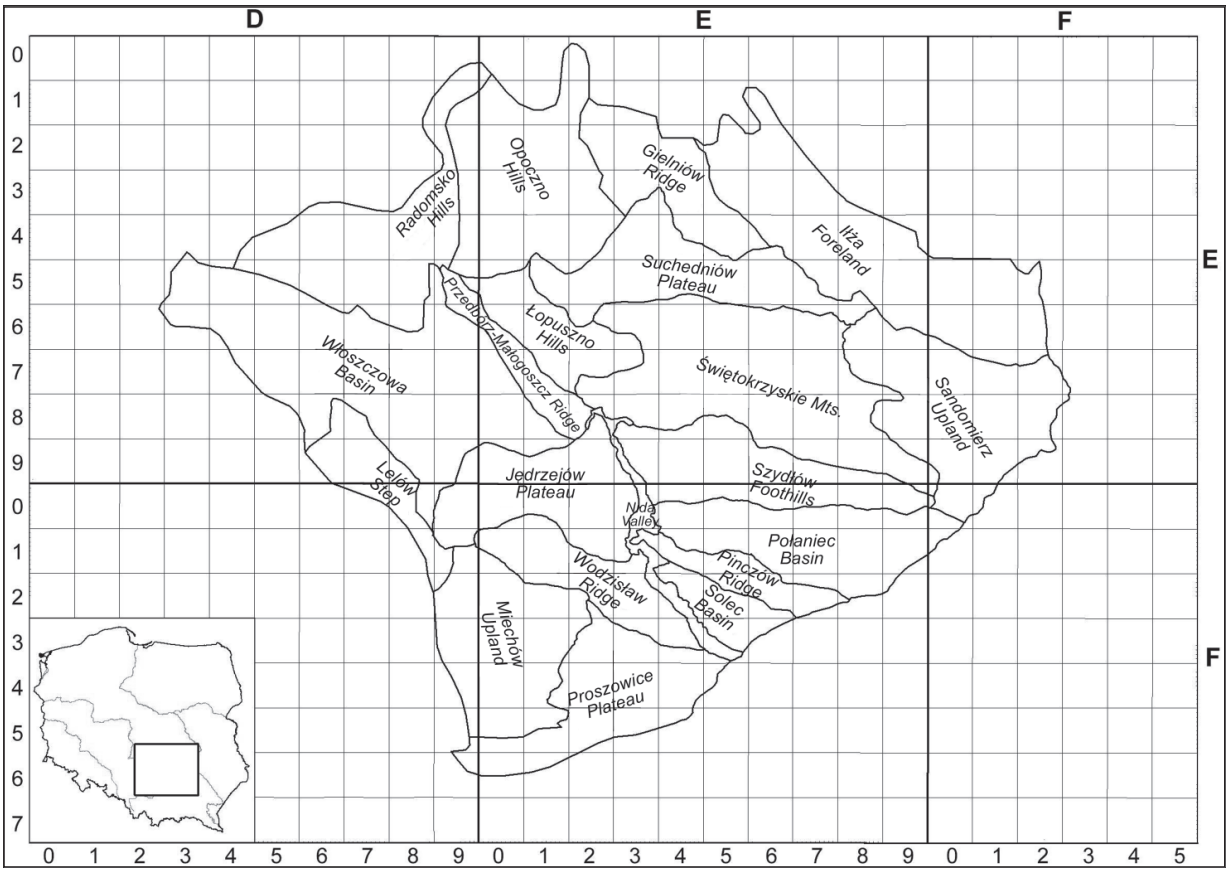

Fig. 2. Division of the Małopolska Upland into mesoregions (according to Kondracki 2001)

trict and the Radom district according to Gumiński (1951). The study area belongs to 3 climatic regions differentiated by Woś (1999): Western Małopolska, Eastern Małopolska, and a small part comprising the Sandomierz region. Mean annual precipitation is 649 mm (varying from 550 to 800 mm between years). The lowest precipitation is observed in the Nida Basin and the highest in the Świętokrzyskie Mts. On average, snow cover first occurs on 22 December, disappears on 25 March, and persists for 69 days (over 100 days in the Świętokrzyskie Mts.). Annually, 41 clear days, 127 cloudy days, 45 frosty days, 85 days of slight frost, and 233 warm days are recorded. Mean annual air temperature is 7°C (3.8°C in January and 17.6°C in July). The growing season lasts 212 days on average (Gumiński 1951; Chrzanowski 1986; Niedźwiedź & Limanówka 1992; Woś 1999; Żmudzka *et al*. 2000).

The diversified geological structure, land relief, and climatic factors create conditions favourable for the occurrence of a variety of vegetation types, including xerothermic communities.

2.2. Data processing

Data on the occurrence of species belonging to the genus *Orobanche* in the Małopolska Upland were collected in the Polish Uplands province, Małopolska Upland subprovince, macroregions:

1. Przedbórz Upland with its 6 mesoregions: Radomsko Hills (Wzgórza Radomszczańskie), Opoczno Hills (Wzgórza Opoczyńskie), Lelów Step (Próg Lelowski), Włoszczowa Basin (Niecka Włoszczowska), Przedbórz-Małogoszcz Ridge (Pasmo Przedborsko-Małogoskie), Łopuszno Hills (Wzgórza Łopuszańskie);
2. Nida Basin with its 8 mesoregions: Jędrzejów Plateau (Płaskowyż Jędrzejowski), Miechów Upland (Wyżyna Miechowska), Proszowice Plateau (Płaskowyż Proszowicki), Wodzisław Ridge (Garb Wodzisławski), Nida Valley (Dolina Nidy), Solec Basin (Niecka Solecka), Pińczów Ridge (Garb Pińczowski), Połaniec Basin (Niecka Połaniecka);
3. Kielce Upland with its 6 mesoregions: Suchedniów Plateau (Płaskowyż Suchedniowski), Gielniów Ridge (Garb Gielniowski), Iłża Foreland (Przedgórze Iłżeckie), Świętokrzyskie Mts. (Góry Świętokrzyskie), Sandomierz Upland (Wyżyna Sandomierska), Szydłów Foothills (Pogórze Szydłowskie) (Figs. 1-2).

Data were collected between 1999 and 2011. Investigations were intensified between 2006 and 2010. Only localities recorded in my observations and identified or confirmed between 2006 and 2011 as well as verified herbarium data are listed below. Herbarium acronyms are given after Mirek *et al*. (1997). Published data not confirmed by me in the field or undocumented by

herbarium material are not included, due to frequent determination errors. All available herbarium materials of the genus *Orobanche* from the Małopolska Upland were revised (KRA, KRAM, KTC, KTU, LBL, LOD, POZ, WSRP, and private herbaria). I also verified herbarium collections of specimens of *O. elatior* s.str. and *O. kochii* from all over Poland (BIL, LOD, KRAM, KRA, KTC, KTU, LBL, POZ, WA, WRSL, and private herbaria). The herbarium material collected by me is deposited in the Herbarium of the Department of Botany, Institute of Biology, Jan Kochanowski University in Kielce (KTC) and a small part in the Herbarium of the Jagiellonian University in Kraków (KRA).

The species are listed alphabetically. Their nomenclature follows Mirek *et al*. (2002). Names of syntaxa follow Matuszkiewicz (2006). Detailed lists of localities are presented in Appendices. In the lists, localities are arranged alphabetically within mesoregions (abbreviated according to their names in Polish). ATPOL grid data are specified for each locality according to the methodology described by Zając (1978, see also http://www.ib.uj.edu.pl/chronpol/). The first 2 digits following capital letters denote the 10 km square, and the next 2 digits denote the 2.5 km square (this division is accepted for the Małopolska Upland). The localities are described as follows: position in the classification of mesoregions, geographic location, habitat description, abundance (in brackets), ATPOL grid unit. The following information is also given for most localities: geographic coordinates and elevation (above sea level), and for revised exsiccata the collector and collection date, exsiccata number, and the herbarium acronym. Habitats are given for all the species. Plant communities in which a species was observed are specified for a majority of them. The distribution of each taxon is mapped in the Małopolska Upland, in 2.5 km × 2.5 km cartogram units according to the methodology of the ATPOL grid system (mentioned above), based on the localities included in the Appendices. Host plants were also observed at the localities of individual species by delicately exposing the soil with a gardening shovel.

3. Results

List of species and localities

Orobanche alba Stephan ex Willd.

It is rarely reported from Poland, mostly from its S and SE parts: the Małopolska Upland, Lublin Upland (Wyżyna Lubelska), Middle Roztocze, Volhynian Upland (Wyżyna Wołyńska), Polesie, Subcarpathia (Podkarpacie), and the Carpathian Mts., especially the Bieszczady Mts. (Mądalski 1967; Zając & Zając 2001; Kaźmierczakowa 2008; Piwowarczyk 2010b; Piwo-

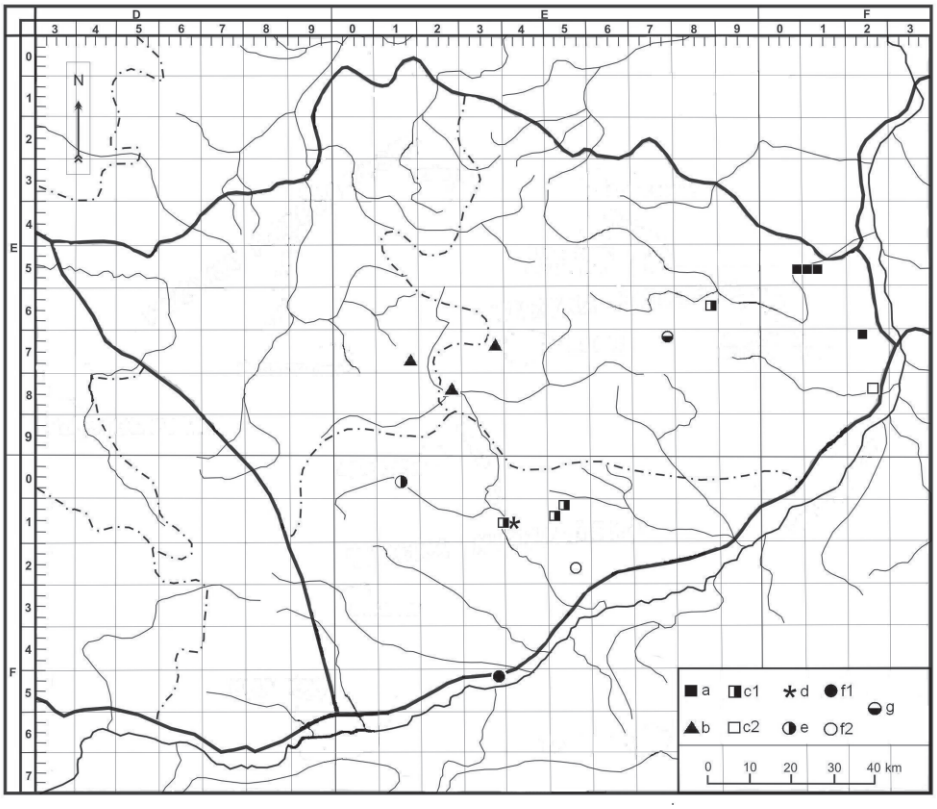

Fig. 3. Distribution of *Orobanche* localities in the Małopolska Upland: a – *O. alba*, b – *O. alsatica*, c1 – *O. arenaria*, c2 – *O. arenaria*, unconfirmed locality, d – *O. coerulescens*, e – *O. pallidiflora*, f1 – *O. ramosa*, f2 – *O. ramosa*, unconfirmed locality, g – *O. bartlingii*

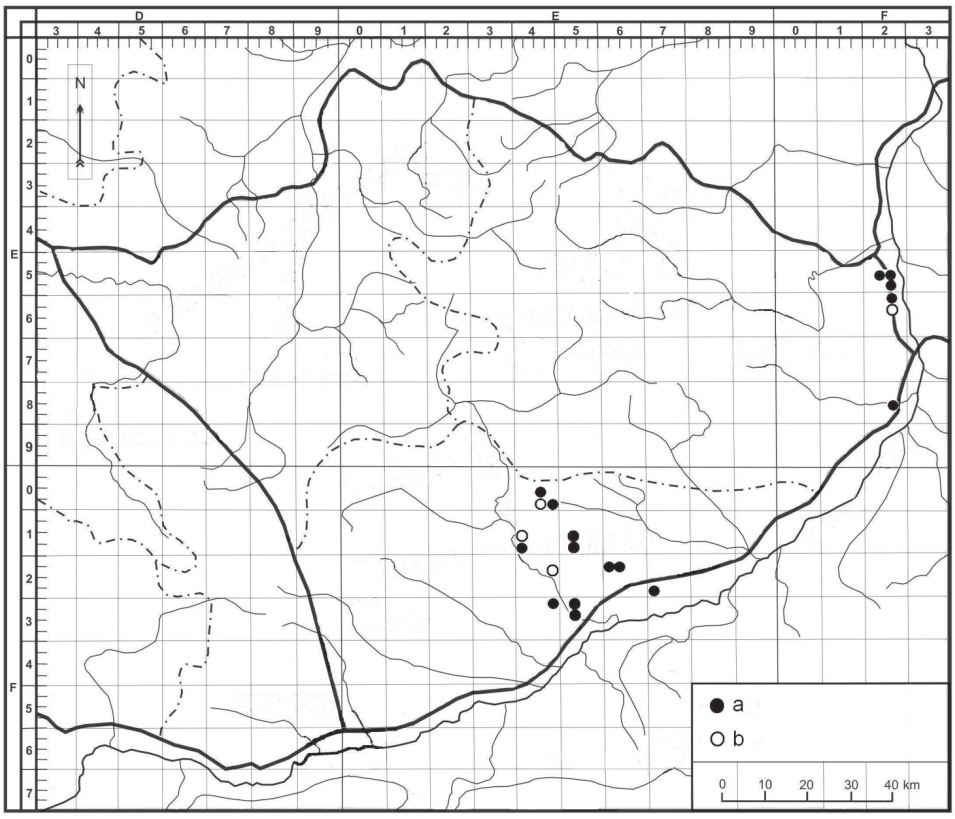

Fig. 4. Distribution of localities of *Orobanche caryophyllacea* in the Małopolska Upland
Explanations: a – new or confirmed localities, b – unconfirmed localities

warczyk *et al*. 2011). The only localities recorded in the Małopolska Upland to date are in the Iłża Foreland (Piwowarczyk 2010b) (Fig. 3, Appendix 1). The species occurs in the study area in xerothermic grasslands and scrubs, on loess slopes, margins of young pine stands growing on hills on chalky rendzinas. It prefers xerothermic grasslands of the alliance *Cirsio-Brachypodion pinnati* (class *Festuco-Brometea*) and fringe communities of the alliance *Geranion sanguinei* (class *Trifolio-Geranietea sanguinei*) developed on para-rendzinas and rendzinas. It flowers from mid-June until late July. It parasitizes *Salvia verticillata*.

Orobanche alsatica Kirschl.

It currently occurs only in S and SE Poland, at 14 localities in the Silesia-Kraków Upland (Wyżyna Śląsko-Krakowska), Małopolska Upland, Lublin Upland, Middle Roztocze, and Polesie (Piwowarczyk 2012e). *O. alsatica* mostly occurs on shallow chalky rendzinas, in xerothermic oak forests belonging to the class *Potentillo albae-Quercetum*, in thermophilous and light hazel scrub belonging to the association *Peucedano cervariae-Coryletum* or in fringe communities of the alliance *Geranion sanguinei*; it rarely occurs in xerothermic grasslands of the alliance *Cirsio-Brachypodion pinnati*. The species flowers in June and the first half of July. *Peucedanum cervaria* is its host. *O. alsatica* was recorded in the Małopolska Upland for the first time (Fig. 3, Appendix 2).

Orobanche arenaria Borkh.

Until recently, it was known from few localities in the literature and was considered to be extinct in Poland (Zarzycki & Szeląg 2006). It was previously reported from only 6 localities in Poland, in Lower Silesia (Szczęśniak 2003), the Nida Basin (Piwowarczyk & Przemyski 2009, 2010), Middle Vistula Gap (Piwowarczyk *et al*. 2011), and Częstochowa Upland (Piwowarczyk 2012a). The species now occurs in the Nida Basin and Sandomierz Upland in the Małopolska Upland (Fig. 3, Appendix 3). It flowers in late June and early July. It occurs in xerothermic grasslands, wastelands, on field margins, mostly on calcareous sands. The communities are dominated by species characteristic of the classes *Festuco-Brometea* and *Koelerio-Corynephoretea canescentis*, with some species of the classes *Molinio-Arrhenatheretea*, *Artemisietea vulgaris* and *Agropyretea intermedio-repentis* (Piwowarczyk & Przemyski 2010; Piwowarczyk *et al*. 2011). It parasitizes *Artemisia campestris*.

Orobanche bartlingii Griseb.

In Poland, the species occurs mostly in the Silesia-Kraków Upland (Szeląg 2001a, 2001b; Rakowski 2004; Nowak-Dańda & Dańda 2006; Piwowarczyk *et al*. 2009; Piwowarczyk 2011b; Krajewski 2011). In this study it was recorded in the Małopolska Upland for the first time (Fig. 3, Appendix 4). It prefers here ecotone communities of the classes *Trifolio-Geranietea sanguinei*

and *Festuco-Brometea* (Piwowarczyk *et al*. 2009). The species parasitizes *Libanotis pyrenaica*.

Orobanche caryophyllacea Sm.

It mostly occurs in xerothermic grasslands of the alliance *Cirsio-Brachypodion pinnati*, xerothermic fringe vegetation of the class *Trifolio-Geranietea sanguinei*, shrub species of the class *Rhamno-Prunetea*, in wastelands, former excavation pits, sporadically in oak-hornbeam communities, on chalky rendzinas and gypsum, less frequently on loesses, usually S, SE and SW-facing. The species is also rarely recorded in the community *Carex glauca-Tetragonolobus maritimus* ssp. *siliquosus*, developing in the contact zone of *Thalictro-Salvietum pratensis* patches and meadow communities of the alliance *Arrhenatherion*, previously known only from the Nida Basin. In the Małopolska Upland its localities are recorded mostly in the Nida Basin and at the border between Iłża Foreland and Middle Vistula Gap (Fig. 4, Appendix 5). In the study area, it parasitizes *Galium mollugo,* rarely *G. verum*, *Cruciata glabra*, and *G. odoratum*, at one locality.

Orobanche coerulescens Stephan in Willd.

The species is known in Poland primarily from now historical localities in Pomerania (Zając & Zając 2001). It has been recently recorded at single localities in the Podlasie Bug Gap (Podlaski Przełom Bugu) (Ciosek 2002), Nida Basin (Piwowarczyk & Przemyski 2009), Drohiczyn Plateau (Wysoczyzna Dorohiczyńska), and Łódź Hills (Wzniesienia Łódzkie) (Piwowarczyk 2011c). In the study area, the species grows near Pińczów (Fig. 3, Appendix 6). It prefers ecotone zones of xerothermic grasslands, wastelands, and arable fields. The communities are dominated by species of the classes *Koelerio glaucae-Corynephoretea canescentis* and *Festuco-Brometea*, with some meadow, ruderal, and field weed, i.e. segetal species (Piwowarczyk & Przemyski 2009). It parasitizes *Artemisia campestris*.

Orobanche species parasitizing *Centaurea scabiosa*

Broomrapes parasitic on *Centaurea scabiosa* are considered by most authors as a sole taxon, *Orobanche elatior* Sutton. However, research in Central Europe revealed the existence of 2 distinct species that are not closely related. Their correct names are *O. kochii* F. W. Schultz and *O. elatior* Sutton (Zázvorka 2010). The most important characters distinguishing the 2 species are given in Table 1 (after Zázvorka 2010).

Like generally in Europe, until recently both taxa were treated in Poland as one taxon, *Orobanche elatior* Sutton (*O. elatior* s.str.). It is very rare in Poland and also in Europe (Zázvorka 2010; Piwowarczyk unpubl. data).

The distribution and habitat conditions of *Orobanche elatior* s.str. and *O. kochii* in the Małopolska Upland (Fig. 5, Appendices 7-8) and Poland (Figs. 6-7) are

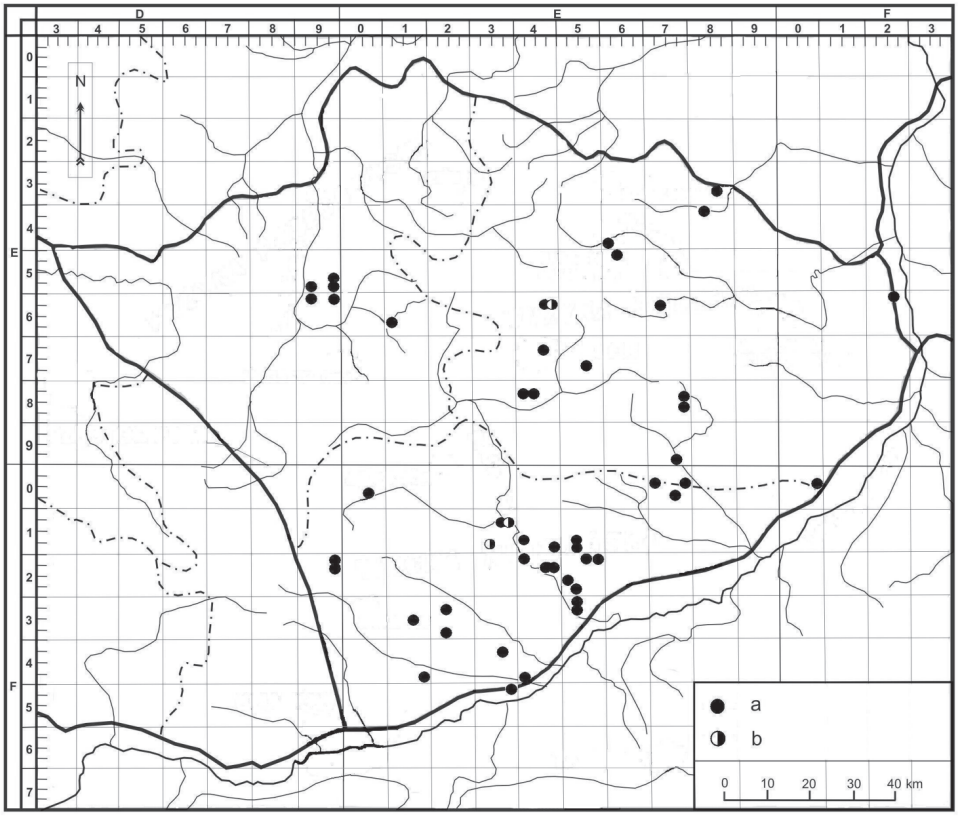

Fig. 5. Distribution of *Orobanche* localities in the Małopolska Upland: a – *Orobanche kochii*, b – *O. elatior* s.str.

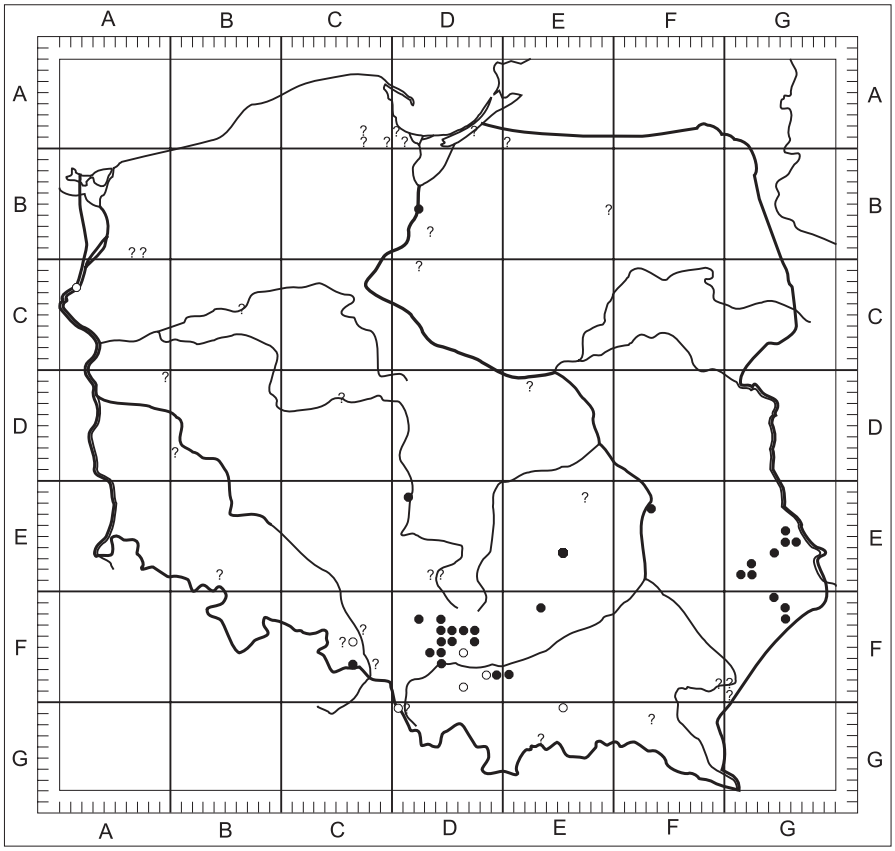

Fig. 6. Distribution of *Orobanche elatior* s.str. in Poland
Explanations: ● – new locality or confirmed after 2000, ○ – locality known from herbarium materials but not confirmed after 2000, ? – literature data, difficult to differentiate

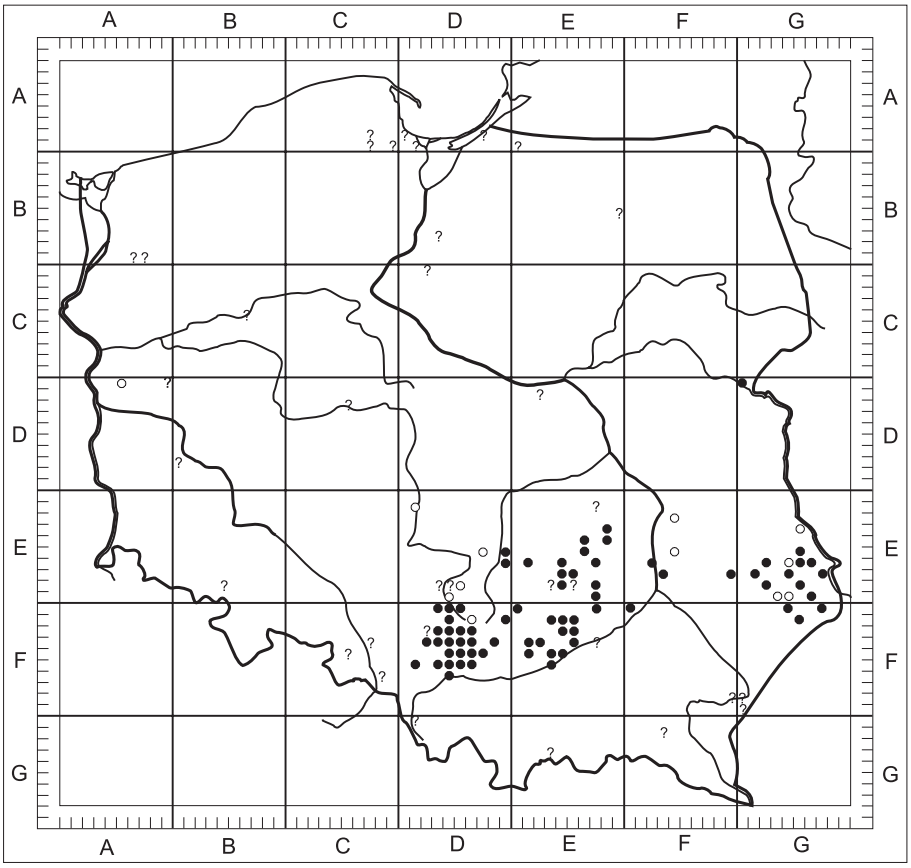

Fig. 7. Distribution of *Orobanche kochii* in Poland
Explanations: ● – new locality or confirmed after 2000, ○ – locality known from herbarium materials but not confirmed after 2000, ? – literature data, difficult to differentiate

given below, based on the revision of herbarium materials and my field studies.

Orobanche elatior Sutton

Orobanche elatior s.str. occurs in Poland in the Silesia-Kraków and Lublin Uplands, Roztocze and Polesie, rarely in the Małopolska Upland, sporadically in the lower Vistula and Oder valleys, the Głubczyce Plateau (Płaskowyż Głubczycki), Beskid Śląski Mts. and Wieliczka Foothills (Pogórze Wielickie) (Fig. 6) (e.g. Nowak & Nowak 2002; Bartoszek & Piwowarczyk 2008; Zázvorka 2010; Piwowarczyk unpubl. data; Krajewski unpubl. data).

This species has so far been recorded in the Małopolska Upland only at 3 localities in the Nida Basin and Świętokrzyskie Mts. (Fig. 5, Appendix 7). In the study area, it was observed in strongly insolated habitats, on chalky rendzinas, in initial communities with a low density of herbaceous vegetation, i.e. margins of wastelands and arable fields, quarries, but also in a forest glade in xerothermic grassland belonging to the alliance *Cirsio-Brachypodnion pinnati*. The species flowers in June, less frequently in July. *Centaurea scabiosa* is the host.

Orobanche kochii F. W. Schultz

The species (as *Orobanche elatior* s.l.) was known only from several localities in the study area prior to my studies. In the Małopolska Upland, the taxon was widespread mostly in the Nida Basin and Kielce Upland, especially in the Świętokrzyskie Mts. mesoregion, less in the Przedbórz Upland (Fig. 5, Appendix 8). The species is recorded in xerothermic and meso-xerothermic grasslands, also often on roadsides, in fallows and on margins of arable fields, edges of quarries and excavation pits, mostly on shallow chalky rendzinas. It prefers grasslands of the alliance *Cirsio-Brachypodion pinnati* and initial communities growing on chalk. It rarely forms larger local populations. It occurs at warm, sunny sites, but is also often recorded at N-facing localities. *O. kochii* flowers from June until early August (September), sometimes also until October. *Centaurea scabiosa* is its host in the study area.

Orobanche lutea Baumg.

Among *Orobanche* species, this one has the most abundant localities and populations in the Małopolska Upland (Fig. 8, Appendix 9). It is mostly recorded in thermophilous grasslands and scrub, fallows, wastelands, field borders, mid-field escarpments, fields, and excavation pits. It colonizes soils formed on chalky rendzinas and on gypsum, rarely in the forest. *Orobanche lutea* is found in communities belonging to the alliance *Cirsio-Brachypodion pinnati* and the classes *Trifolio-Geranietea sanguinei* and *Rhamno-Prunetea*. It is also sporadically recorded in the associations *Sisymbrio-Stipetum capillatae* and *Carex glauca-Tetragonolobus maritimus* ssp. *siliquosus*. The species flowers in May and June. It parasitizes *Medicago*

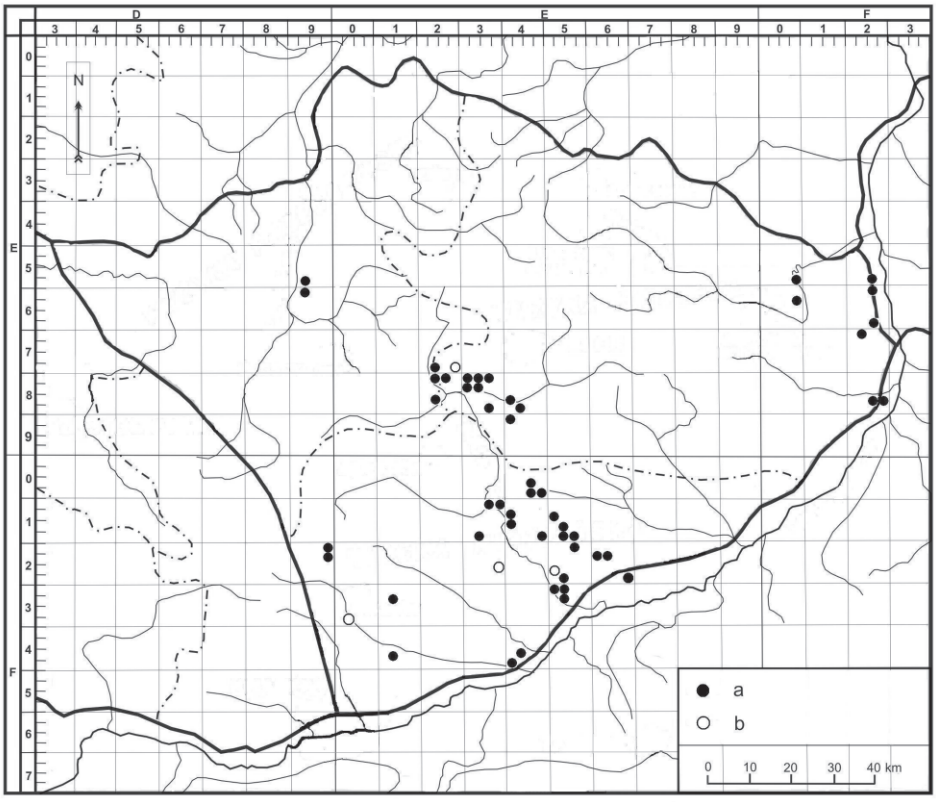

Fig. 8. Distribution of localities of *Orobanche lutea* in the Małopolska Upland: a – new or confirmed localities, b – unconfirmed localities

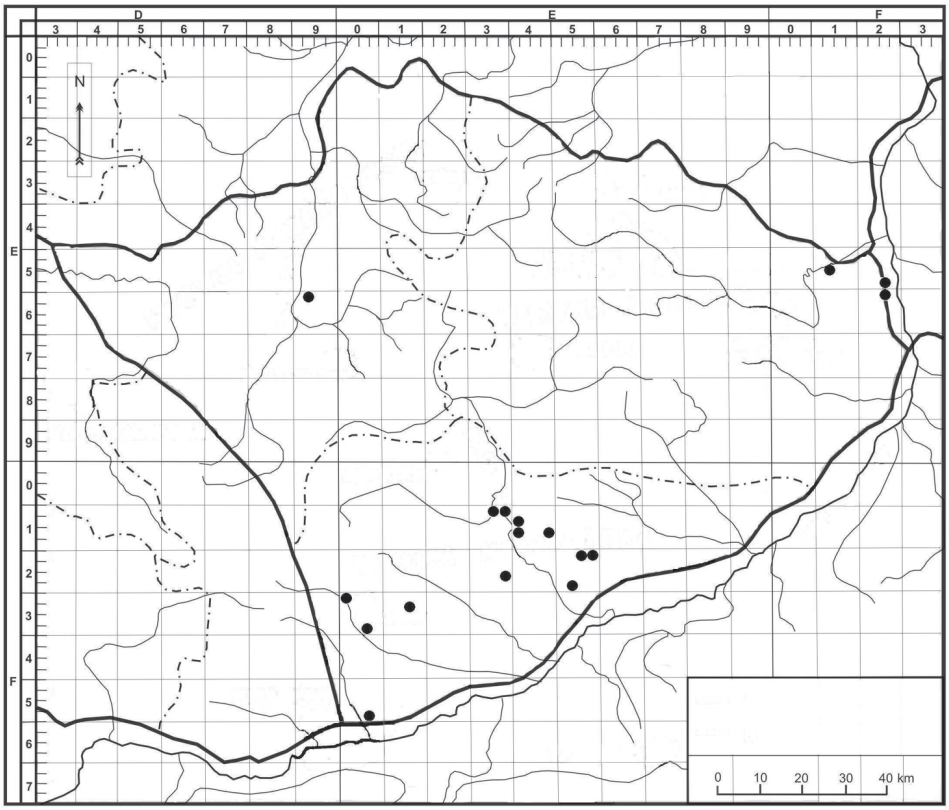

Fig. 9. Distribution of localities of *Orobanche picridis* in the Małopolska Upland

falcata; sporadically recorded on *M. sativa* and *M.* ×*varia*.

Orobanche pallidiflora Wimm. & Grab.

The species was recorded in ecotone zones of arable fields, wastelands, and xerothermic grasslands, at only one locality in the Jędrzejów Plateau (Fig. 3, Appendix 10). No specimens were recorded in 2010 and 2011 there. The species is threatened as it colonizes unstable habitats, exposed to weed-killing agents. *O. pallidiflora* is polyphagous, recorded on species of the genera *Cirsium* and *Carduus* in Poland. In the Małopolska Upland it parasitized *Cirsium arvense* (Piwowarczyk *et al.* 2010).

Orobanche pallidiflora was also reported by Wnuk (1978) from Bukowa Mt., Dobromierz, and Rączki (Przedbórz-Małogoszcz Range, adjacent to the study area). Wnuk and Pisarek (2008) reported *O. ramosa* from the Murawy Dobromierskie reserve. Herbarium materials are unavailable and were not verified. I visited these locations but found other species: *O. lutea, O. kochii* and *O. picridis*.

Orobanche picridis F. W. Schultz

It is mostly reported in Poland from the Silesia-Kraków Upland, Małopolska Upland, Lublin Upland, and Przemyśl Foreland (Pogórze Przemyskie) (Bróż *et al.* 2001; Kucharczyk 2001; Zając & Zając 2001; Piwowarczyk 2010b, 2012c; Piwowarczyk *et al.* 2011). In the Małopolska Upland, it occurs in the Iłża Foreland, Nida Basin, Miechów Upland, and Przedbórz-Małogoszcz Range (Fig. 9, Appendix 11). It is usually very abundant at the localities. It prefers habitats not very well established, with a low density of herbaceous vegetation, on heavy chalky rendzinas, strongly insolated, S-facing, less frequently SE and SW-facing. It colonizes abandoned fallows and wastelands, field margins, initial xerothermic grasslands, and also often disturbed sites, e.g. rooted by wild boar or periodically ploughed. They are mostly ecotone communities, in semi-ruderal xerothermic pioneer communities belonging to the suballiance *Dauco-Melilotenion* (class *Artemisietea vulgaris*) with a high contribution of species of the class *Festuco-Brometea*, and some species of the classes *Molinio-Arrhenatheretea*, *Trifolio-Geranietea sanguinei*, *Stellarietea mediae* and *Agropyretea intermedio-repentis*. It flowers from mid-June until late July (August). It parasitizes *Picris hieracioides*.

Orobanche ramosa L.

The species has not been confirmed in Poland for many years (Zając & Zając 2001). In the past it was recorded infrequently, mostly as a parasite of hemp (*Cannabis sativa*, cultivated for fibre or oil) and tobacco fields. The taxon has disappeared following the discontinuation of hemp cultivation, the use of crop rotation and seed cleaning, and the introduction of chemical agents and varieties resistant to infection. It was

Table 1. Most important characters distinguishing *Orobanche kochii* and *O. elatior* s.str. (after Zázvorka 2010)

Characters	*O. kochii*	*O. elatior* s.str.
Stem height	usually 30-40 cm	usually 40-60 cm
Leaf shape	broad at base, ovate-triangular	narrow, elongated, linear-lanceolate
Corolla colour	carrot red to whitish-rosaceous	yellow to pale brown (ochre)
Back of corolla	middle part nearly straight	regularly curved throughout
Colour of dried specimens	brownish-rusty	pale brown (ochre)
Flowering period	long: (late June) July-August	short (only 2-3 weeks): mid and late June
Host	*Centaurea scabiosa*	*Centaurea scabiosa*

recorded at one existing locality in the Małopolska Upland (Fig. 3, Appendix 12), in a tobacco field. Outside the study area, it was recorded only in the Vistula Lowland (Nizina Nadwiślańska) (Piwowarczyk 2012b).

4. Conclusions and discussion

The genus *Orobanche* in Poland occurs most abundantly in the uplands. This study continues investigations conducted in the Lviv-Lublin Upland, the Volhynian Upland, and southern Polesie, where the occurrence of 8 *Orobanche* species was recorded (Piwowarczyk *et al*. 2011). A further study on the occurrence of the genus in the Silesia-Kraków Upland is forthcoming (Piwowarczyk & Krajewski mscr.).

Twelve species of the genus *Orobanche* were recorded during investigations in the Małopolska Upland: *O. alba* (4 localities), *O. alsatica* (3), *O. arenaria* (5), *O. bartlingii* (1), *O. caryophyllacea* (17), *O. coerulescens* (1), *O. kochii* (47), *O. elatior* s.str. (3), *O. pallidiflora* (1), *O. picridis* (15), *O. lutea* (47), and *O. ramosa* (2). Thus in the study area *O. lutea* and *O. kochii* are the most frequently recorded species; *O. caryophyllacea* and *O. picridis* are less common, while the other species have only 1-5 localities each. Eight species (*O. alba*, *O. alsatica*, *O. arenaria, O. bartlingii, O. coerulescens, O. elatior* s.str., *O. kochii*, *O. pallidiflora*) were not known or uncertain in the study area before 1999, when the investigations began.

Two additional species are not included in the list above. *Orobanche purpurea* was reported from the Małopolska Upland from the Dąbie reserve near Klonów (Szwagrzyk 1987), but my field studies did not confirm its occurrence there. The record could not be verified as herbarium materials are absent. *O. flava* was reported erroneously from the Chęciny-Kielce Landscape Park (Przemyski *et al*. 2010), as the specimens proved to be *O. lutea* in fact.

Verified distribution maps of *Orobanche elatior* s.str. and *O. kochii* in Poland are presented for the first time in this study. *O. elatior* s.str. is a rare taxon. Its local populations are small and are sometimes spontaneous. The species mostly occurs in the Silesia-Kraków Upland, Lublin Upland, Roztocze, Polesie, Volhynian Upland, and sporadically in the Małopolska Upland, the Wieliczka Foreland, the Głubczyce Plateau, and in the lower Vistula and Warta valleys. It was recorded in the Bielinek reserve on the lower Oder river in the past. *O. kochii* is recorded considerably more frequently and its populations are definitely larger. It mostly occurs in the Silesia-Kraków Upland, Małopolska and Lublin Uplands, Middle Roztocze, Volhynian Upland, and Polesie (Figs. 6-7). In contrast to the reports by Zázvorka (2010), both species often occur at the same localities in Poland. Many records should be confirmed in the field, especially when herbarium data are not available. Old literature data, not supplemented with herbarium specimens, are particularly difficult to verify. A detailed

Table 2. List of threatened *Orobanche* species in the Małopolska Upland

Species	Red list of Małopolska Upland*	Red list of Poland**	Red Data Book of Poland 2001***	Red Data Book of Poland 2012***
1. *Orobanche alba*	CR	-	-	-
2. *O. alsatica*	-	E	-	EN
3. *O. arenaria*	CR	Ex	-	CR
4. *O. bartlingii*	-	R	VU	VU
5. *O. caryophyllacea*	VU	-	-	-
6. *O. coerulescens*	CR	E	-	CR
7. *O. elatior*♦	VU	R	-	-
8. *O. lutea*	VU	-	-	-
9. *O. pallidiflora*	-	R	-	-
10. *O. picridis*	EN	R	EN	EN
11. *O. ramosa*	-	R	-	-

Explanations: * – Bróż & Przemyski (2009), ** – Zarzycki & Szeląg (2006), *** – Kaźmierczakowa & Zarzycki (2001, 2012), ♦ – contains *O. elatior* s.str. and *O. kochii*

list of localities of both species and their preferred plant communities will be published separately (Piwowarczyk mscr.; Piwowarczyk & Krajewski mscr.).

Seven of the 12 taxa are red-listed in the Małopolska Upland (Bróż & Przemyski 2009). Eight taxa were red-listed in Poland by Zarzycki & Szeląg (2006), but only *Orobanche bartlingii* and *O. picridis* were included in the first edition of the red data book by Kaźmierczakowa & Zarzycki (2001). The new edition of this book lists also *O. alsatica*, *O. arenaria*, and *O. coerulescens* (Kaźmierczakowa & Zarzycki 2012; Piwowarczyk 2012e, 2012f, 2012g) (Table 2). Some rare broomrape species are not included in regional red lists or are misclassified in threat categories due to the poor recognition of the genus, so their status should be updated.

Fifteen host species of the *Orobanche* species recorded in the Małopolska Upland belong to 6 families, namely Apiaceae: *Peucedanum cervaria* (*O. alsatica*), *Libanotis pyrenaica* (*O. bartlingii*); Asteraceae: *Artemisia campestris* (*O. arenaria, O. coerulescens*), *Centaurea scabiosa* (*O. elatior* s.str., *O. kochii*), *Cirsium arvense* (*O. pallidiflora*), *Picris hieracioides* (*O. picridis*); Fabaceae: *Medicago falcata*, *M. sativa, M.* ×*varia* (*O. lutea*); Labiatae: *Salvia verticillata* (*O. alba*); Rubiaceae: *Galium mollugo*, *G. odoratum*, *G. verum, Cruciata glabra* (*O. caryophyllacea*); and Solanaceae: *Nicotiana tabacum* (*O. ramosa*).

The most abundant localities were recorded in the Nida Basin, especially in the Pińczów Ridge, and more scattered localities in the Świętokrzyskie Mts., Iłża Foreland, Przedbórz-Małogoszcz Range or Łopuszno Hills. These mesoregions abound in habitats preferred by species of the genus *Orobanche*, such as xerothermic grasslands, fallows and wastelands, former excavation pits and quarries, thermophilous scrubs, river valley slopes, hills, mid-field escarpments, ravines or gorges, developed mostly on calcareous rocks and gypsum. The soils are usually chalky rendzinas, marls or loesses. Poland's best-preserved and diversified xerothermic habitats also occur in the area. Specific climatic conditions resulting from the diversified land relief, exposure, slope inclination, varied substrate forms, and man-transformed sites also have a considerable influence on the distribution of the genus *Orobanche*. The Małopolska Upland, and especially the Nida Basin and the Chęciny region, are some of the warmest regions in Poland, but climatic conditions within the study area vary considerably. In Poland, the broomrape species discussed here are most diverse and have the highest numbers of records in the Małopolska Upland.

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Appendices

Abbreviations used in Appendices: ecol. site – ecological site (Polish: *użytek ekologiczny*, a small protected area); leg. – collected by; n. – near; res. – reserve; sect. – section; v. – valley; vid. – seen by; xer. gras. – xerothermic grassland; mesoregions: DN – Dolina Nidy (Nida Valley); GP – Garb Pińczowski (Pińczów Ridge); GŚ – Góry Świętokrzyskie (Świętokrzyskie Mts.); GW – Garb Wodzisławski (Wodzisław Ridge); MPW – Małopolski Przełom Wisły (Middle Vistula Gap); NP – Niecka Połaniecka (Połaniec Basin); NS – Niecka Solecka (Solec Basin); PI – Przedgórze Iłżeckie (Iłża Foreland); PJ – Płaskowyż Jędrzejowski (Jędrzejów Plateau); PP – Płaskowyż Proszowicki (Proszowice Plateau); PPM – Pasmo Przedborsko-Małogoskie (Przedbórz-Małogoszcz Range); PS – Płaskowyż Suchedniowski (Suchedniów Plateau); PSz – Pogórze Szydłowskie (Szydłów Foreland); WŁ – Wzgórza Łopuszańskie (Łopuszno Hills); WM – Wyżyna Miechowska (Miechów Upland); WS – Wyżyna Sandomierska (Sandomierz Upland).

Appendix 1. List of localities of *Orobanche alba*

PI: 1. Bałtów, ecotone zone of fringe communities and xer. gras. on left bank of Kamienna river, S-facing (>15), FE5023, 51°01'07.7"N, 21°32'55.8"E, 148 m, leg. B. Maciejczak, 2007 (KTC), leg. R. Piwowarczyk, 24.06.2007 (KTC), [Bałtów, sunny slopes of steep edge of Kamienna v., leg. T. Głazek (KRA, 0225393); clayey, dark ravine, Bałtów, leg. A. Pieńkowska, 05.06.1961 (KRAM); Bałtów, sunny slope, leg. A. Fotyga, 17.07.1974 (KTU, 10550)]; **2.** Skarbka Dolna, xer. gras. on slopes of Kamienna v., S-facing (<10), FE5120, 51°00'58"N, 21°34'38"E, 174 m, leg. R. Piwowarczyk, 04.07.2004 (KTC); **3.** Pętkowice, xer. gras. on slope of Kamienna v., S-facing (>5), FE5121, 51°01'07"N, 21°35'10"E, 174 m, leg. R. Piwowarczyk, 26.06.2003, 04.07.2004 (KTC); **4.** S of Lasocin, xer. gras. and thermophilous fringe communities on slopes and at the foot of Bandocha hills, SW-facing (>80), FE7201, 50°53'07.5"N, 21°45'12.2"E, 165 m, leg. R. Piwowarczyk, 25.06.2002 (KRA, 0267162), leg. R. Piwowarczyk, 03.07.2004, 15.07.2005, 24.06.2007 (KTC).

Appendix 2. List of localities of *Orobanche alsatica*

GŚ: 1. Grabina Mt. n. Kielce, S-, SE-facing; xer. gras. and fringe communities, in former excavation pits (<50), EE7313, 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); **2.** Grzywy Korzeckowskie mountain range n. Korzecko, xerothermic oak forest, forest sect. 188, 1 specimen in 2007, not observed in 2008, EE8213, 50°47'42"N, 20°24'11"E, 315 m, vid. M. Fałdziński, R. Piwowarczyk, 07.2007; **WŁ: 3.** Zabłoty Mt. n. Małogoszcz, xerothermic oak forest between Skorków and Wrzosówka, forest sect. 11, SW-facing (<15), EE7123, 50°51°23.1"N, 20°14'44.6"E, 282-323 m, leg. A. Adamiec, 2008, leg. R. Piwowarczyk, 30.07.2008 (KTC).

Appendix 3. List of localities of *Orobanche arenaria*

GP: 1. Pasturka, between Grodzisko estate in Pińczów and Pasturka village, xer. gras., field margins, fallows, EF1420, 50°30'31"N, 20°33'47"E, 223 m, leg. R. Piwowarczyk, A. Przemyski, 25.06.2007, leg. R. Piwowarczyk, 14.07.2008 (KTC). Scattered, forming 3 subpopulations. About 1030 shoots were recorded in total near Pasturka in 2008 (Piwowarczyk & Przemyski 2010), but the slope foothills and fallows were ploughed in 2009 and alfalfa was sown. The population abundance dropped to about 200 shoots in 2009 and about 100 shoots in 2010; **NP: 2.** Młyny, xer. gras. on a slope of Bród v. (<40), EF1501, 50°32'46.3"N, 20°44'01.5"E, 230 m (Piwowarczyk & Przemyski 2010), leg. R. Piwowarczyk, A. Przemyski, 09.07.2006 (KTC), leg. R. Piwowarczyk, 01.07.2008 (KTC); **3.** Zwierzyniec n. Szaniec, along asphalt road from Szaniec to Busko-Zdrój-Chmielnik dirt road, wastelands n. a gravel pit (>350), EF1510, 50°31'02.2"N, 20°42'35.3"E, 192 m, leg. R. Piwowarczyk, A. Przemyski 05.07.2006, leg. R. Piwowarczyk, 01.07.2008, 23.08.2009 (KTC), (Piwowarczyk & Przemyski 2010); **WS: 4**. Kunów SWW, xer. gras., loess substrate (<20); EE6813, 50°57'00"N, 21°15'53"E, 200 m, vid. B. Sępioł, 2009; **5.** Dwikozy, xer. gras. N of stadium, leg. G. Worobiec, 25.06.1991 (KRAM, 403486), not confirmed by field search in 2008 and 2009.

Appendix 4. List of localities of *Orobanche bartlingii*

GŚ: Cząstków Stary, xer. gras. in a former fallow or arable field, on a steep, right bank of Pokrzywianka river, SWW-facing, (<100), EE7703, 50°53'42.3"N, 21°06'05.1"E, 267 m, leg. R. Piwowarczyk, 30.06.2006, vid. R. Piwowarczyk, 2008, (Piwowarczyk *et al*. 2009).

Appendix 5. List of localities of *Orobanche caryophyllacea*

DN: 1. Wiślica, W part, xer. gras. and scrubs on S, SE and SW-facing slopes (<50), EF3403, 50˚21'01"N, 20˚39'50"E, 171 m, leg. R. Piwowarczyk, A. Przemyski, 08.2006 (KTC); **GP: 2.** Łagiewniki n. Busko-Zdrój, xer. gras., S and SW-facing (Zimne Wody res.) (<50), EF1521, 1531, 50˚28'58.72"N, 20˚44'00"E, 254 m, leg. R. Piwowarczyk, 21.07.2006 (KTC); **3.** Between Kików and Sułkowice, xer. gras. on a former limestone excavation pit (so-called Kamienna Mt.), very abundant but scattered (>200), EF2610, 2611, 50˚25'05.51"N, 20˚51'24"E, 268 m, 50˚25'04"N, 20˚51'38"E, 287 m, leg. R. Piwowarczyk, 28.05.2008 (KTC); **4.** Pasturka, in a hole remaining after excavated stone on forest margin, EF1420, leg. J. Mądalski, 03.06.1966 (KRAM, 494810); **NS: 5.** Xer. gras. by Piestrzec–Biechów road junction (>5), EF2730, leg. A. Przemyski, 08.2008 (KTC); **6.** Oak-hornbeam forest in W part of Grabowiec res. between Gacki and Bogucice I (<100), on *Galium odoratum*. Also in xer. gras. and scrub on oak-hornbeam forest margin in W part of that reserve, on *Galium mollugo*, *G. verum* and *Cruciata glabra* (>50), EF1430, 50˚28'21", 20˚34'33"E, 240 m, vid. A. Przemyski, 2006, leg. R. Piwowarczyk, 02.06.2007, 06.06.2007, 28.05.2008 (KTC); [Grabowiec res. n. Krzyżanowice, grasslands, leg. A. Jasiewicz, 07.06.1957 (KRAM, 414019); Bogucice, Grabowice (probably Grabowiec res.), leg. K. Kaznowski, 13.06.1931 (POZ)]; **7.** Górki n. Szczerbaków, xer. gras. on a slope on gypsum, S, SW and SE-facing (>100), EF3501, 3511, 50˚20'51", 20˚43'54"E, 174 m, 50˚20'55", 20˚44'01"E, 179 m, vid. A. Przemyski, 2007, leg. R. Piwowarczyk, 2007 (KTC); **8.** Skorocice n. Busko Zdrój, gypsum rocks, EF2413, leg. A. Jasiewicz, 07.06.1957 (KRAM, 414009); **NP**: **9.** Between Chomentówek and Sędziejowice, xer. gras. and thermophilous scrubs on S- and SW-facing hills on E and W sides of road (<200), EF0433, 50˚34'23"N, 20˚39'44"E, 264 m, vid. R. Piwowarczyk, A. Przemyski, 2007, leg. R. Piwowarczyk, 06.06.2007, 04.06.2009 (KTC); **10.** Gartatowice, E part, xer. gras. on gypsum, on both sides of road (<100), EF0422, 0432, 50˚34'34"N, 20˚37'33"E, 237 m, vid. R. Piwowarczyk, A. Przemyski, 2007, leg. R. Piwowarczyk, 06.06.2007 (KTC); **11.** Borków, quarry, EF0432, leg. ?, 2001 (KTC); **12.** Samostrzałów, SSE part, xer. gras. (<100), EF0422, 50˚35'18"N, 20˚38'41"E, 244 m, leg. R. Piwowarczyk, 04.06.2009 (KTC); **PI: 13.** Ciszyca Kolonia, xer. gras. at edge and on SE-facing slope of Vistula v. (>100), FE5221, 51˚01'08"N, 21˚46'38"E, 153 m, leg. R. Piwowarczyk, 25.07.2001, 01.06.2002, 21.06.2005 (KTC), (Halamski & Piwowarczyk 2008; Piwowarczyk 2010b; Piwowarczyk *et al*. 2010); **14.** Dorotka n. Tarłów, xer. gras. and scrubs N, S and SE of Dorotka, S, SE and SW-facing slopes (<30), FE5222, 5232, 51˚00'02"N, 21˚47'05"E, 148 m, leg. R. Piwowarczyk, 01.06.2002, 18.06.2006 (KTC), (Halamski & Piwowarczyk 2008; Piwowarczyk 2010b; Piwowarczyk *et al*. 2010); **15.** Wesołówka, NNE part, S-facing wasteland on chalky rendzina (>15), FE6202, 50˚58'37"N, 21˚47'49"E, vid. R. Piwowarczyk, 1999-2006 (Bróż *et al*. 2001; Halamski & Piwowarczyk 2008; Piwowarczyk 2006; Piwowarczyk *et al*. 2010), absent in 2008-2010; **16.** Słupia Nadbrzeżna (Głazek 1968a, b), SE-facing xer. gras., about 250 m NW of church (>10), FE6212, vid. R. Piwowarczyk, 2001, 2005; [*O. caryophyllacea* was reported from Biedrzychów by Głazek (1968b) but in the field *O. lutea* was recorded, FE6232, leg. R. Piwowarczyk, 2007 (KTC); Bałtów (Błoński 1892, Głazek 1976), a locality of *O. alba* recorded, FE5023, leg. R. Piwowarczyk, 24.06.2007; Ulów res. (Przemyski & Stachurski 1999), a locality of *O. lutea* recorded, FE5033, vid. R. Piwowarczyk, 2007]; **WS: 17.** Dwikozy ecol. site, Dwikozy n. Sandomierz, N of stadium, xer. gras. on S-facing slope of Opatówka v. (>20), FE8222, 50˚44'20"N, 21˚47'03.9"E, 174 m, (Dziubałtowski 1922); leg. R. Piwowarczyk, 27.07.2006 (KTC).

Appendix 6. List of localities of *Orobanche coerulescens*

GP: 1. Between Grodzisko estate in Pińczów and Pasturka, S-facing, EF1420, 50˚30'33"N, 20˚33'44"E, 227 m, leg. R. Piwowarczyk, A. Przemyski, 25.06.2007 (KTC). About 290 shoots were recorded in 2007 (Piwowarczyk & Przemyski 2009), but part of the grassland and wastelands was ploughed in 2008 and alfalfa was planted; weed killers were also used. The population abundance drastically decreased and only about 50 shoots were recorded in 2009 and 40 in 2010-2011.

Appendix 7. List of localities of *Orobanche elatior* s.str.

GP: **1.** NW of Pińczów, margin of a field and a fallow (3), EF1312, 50˚32'08.4"N, 20˚30'46"E, 219 m, leg. R. Piwowarczyk, 09.06.2009 (KTC); **GW**: **2.** Polana Polichno res. n. Młodzawy, xer. gras., oak-hornbeam communities (>8), EF1331, 50˚28'01.9"N, 20˚28'06.7"E, 215 m, leg. R. Piwowarczyk, 27.06.2006, (KTC), vid. R. Piwowarczyk, 06.2009**; GŚ. 3.** Zachełmie n. Zagnańsk, xer. gras. on edges of a closed quarry n. Chełmowa Mt. (<10), EE6413, 50˚58'10"N, 20˚41'28"E, 354 m, vid. A. Przemyski, 09.2011.

Appendix 8. List of localities of *Orobanche kochii*

GP: **1.** NW of Pińczów, wastelands, xer. gras. (>10), EF1312, 50˚32’08.4”N, 20˚30’46”E, 219 m, leg. R. Piwowarczyk, 09.06.2009 (KTC); **2.** NW of road from Pasturka village to forest (Las Pasturski), xer. gras., field margins (>5), EF1420, 50˚30’24.77”N, 20˚34’04”E, 225 m, leg. R. Piwowarczyk, 14.07.2008 (KTC); **3.** Łagiewniki n. Busko Zdrój, S and SW-facing xer. gras. (Zimne Wody res.) (<10), EF1521, 1531, 50˚28’58,72”N, 20˚44’00”E, 254 m, leg. R. Piwowarczyk, 21.07.2006 (KTC); **4.** Wełecz n. Busko Zdrój, S-facing xer. gras. on a hill by surfaced road from Wełecz towards Siesławice (>20), EF1433, 50˚28’14.92”N, 20˚41’12”E, 261 m, leg. R. Piwowarczyk, 21.07.2006 (KTC); **5.** Żerniki Górne, xer. gras. (>10), EF2503, 50˚27’29”N, 20˚47’28”E, 260 m, leg. M. Nobis, 2009 (KRA), (Nobis & Nobis 2010); **6.** S of Ostra Mt. ecol. site, S of Pęczelice, S-facing wastelands and field margins (>10), EF2502, 50˚26’34”N, 20˚47’05”E, 239 m, leg. R. Piwowarczyk, 13.07.2010; **GŚ**: **7.** Between Górno and Górno Zawada, xer. gras. on a hill S of a dirt road (>20), EE7522, 50˚50’38.3”N, 20˚48’02.3”E, 279 m, leg. R. Piwowarczyk, 08.2009 (KTC); **8.** S of Podgórze n. Bilcza, fallows and xer. gras. NNW of an old warehouse, EE8410, 50˚46’57.4”N, 20˚35’48”E, 271 m, vid. M. Fałdziński, 2008; **9.** Folwark n. Bilcza, grasslands, xerothermic scrub, fallows W and NW of a bus stop on road to Kielce, a few local populations: W of bus stop in Bilcza and of road to Kuby Młyny village (>20), EE8411, 50˚46’49.28”N, 20˚36’59”E, 256 m, NW of bus stop in Bilcza and S of Marmurowa Street (>150), 50˚46’58.91”N, 20˚36’39”E, 253 m, vid. M. Fałdziński, 2008, leg. R. Piwowarczyk, 2008 (KTC); **10.** SSW of Kowala Mała, wastelands around a closed warehouse, NEE of Sukowianowa Mt. (<20), EE8410, 50˚47’04.20”N, 20˚34’20”E, 277 m, 50˚47’01”N, 20˚34’35”E, 277 m, vid. M. Fałdziński, 23.07.2007; **11.** Śniadka Druga, xer. gras. on right bank of Psarka river, so-called Wymysłowskie Doły, SW-facing (<50); EE6710, 50˚57’13.22”N, 21˚00’45”, 252 m, vid. A. T. Halamski, R. Piwowarczyk, 04.07.2006, leg. R. Piwowarczyk, 05.08.2008 (KTC); **12.** Zachełmie n. Zagnańsk, xer. gras. on edges of a closed quarry n. Chełmowa Mt. (<20), EE6413, 50˚58’10”N, 20˚41’28”E, 354 m, leg. R. Piwowarczyk, 01.09.2005, leg. M. Nobis, A. Nobis, 2008 (KRA); **13.** Łagów, Dule Gorge, xer. gras. on Zbója Cave, S, SW-facing (>30), EE8713, 50˚45’55”N, 21˚05’28”E, 295 m, leg. R. Piwowarczyk, 17.08.2006 (KTC), **14.** NWW of Zagościniec n. Łagów, xer. gras. (>10), EE8713, 50˚47’15”N, 21˚06’40”E, 309 m, leg. B. Piwowarski, 2010 (KTC); **15.** 150 m N of Łagów–Nowy Staw road, xer. gras., S-facing (>20), EE8723, 50˚46’04.77”N, 21˚06’43”E, 286 m, leg. R. Piwowarczyk, 17.08.2006 (KTC); **16.** Kielce, a fallow behind Institute of Chemistry, Jan Kochanowski University, Świętokrzyska Street (3), EE7412, 50˚52’53”N, 20˚39’31”E, 289 m, leg. B. Maciejczak, 2008 (KTC), vid. B. Piwowarski, 2009; **NP: 17.** Jabłonica, xer. gras., EF0722, leg. A. Pierścińska, 14.05.2009 (KRA); **18.** Jabłonica, Jabłonickie Mts., dry meadow, EF0722, leg. A. Pierścińska, 09.09.2009 (KRA); **NS**: **19.** A hill S of Łatanice–Hołudza road, xer. gras. (>30), EF2520, 50˚24’54.8”N, 20˚42’25.3”E, 197 m, leg. R. Piwowarczyk, 30.09.2009 (KTC); **20.** Krzyżanowice res. n. Gacki, S part, xer. gras. and a wasteland (>10), EF2400, 50˚27’11.65”N, 20˚34’04.92”E, 219 m, vid. R. Piwowarczyk, 2007; **21.** Skotniki Górne res. n. Skotniki Górne village, xer. gras. between road and railway tracks, S and SW-facing, sporadically N and NE (>50), EF2412, leg. R. Piwowarczyk, 07.2007 (KTC); **22.** Skorocice res. n. Skorocice village, xer. gras. (>10), EF2413, vid. R. Piwowarczyk, 2007; **23.** Górki Pierwsze, xer. gras., on gypsum, roadsides, on both sides of road from Szczerbaków-Strążyska dirt road (>10), EF3501, 3511, 50˚20’55.03”N, 20˚44’01”N, 178 m, 50˚20’54,72”N, 20˚44’02”E, 179 m, leg. R. Piwowarczyk, 2006 (KTC); **24.** Przęślin res. n. Chotel Czerwony, xer. grasslands (>5), EF2531, 50˚22’41.87”N, 20˚42’59”E, 188 m, vid. R. Piwowarczyk, 2006; **PP: 25.** Gniazdowice, gypsum slope, EF4133, leg. K. Towpasz, 11.07.1995, 29.06.1998 (KRA); **26.** Kaczkowice n. Kazimierza Wielka, EF4430, leg. K. Towpasz, 21.06.1999, vid. R. Piwowarczyk, 2008; **27.** Pałecznica, xer. gras., EF3231, leg. K. Towpasz, 08.07.2003; **28.** Kazimierza Wielka, W part, between a balk and an escarpment, EF4312, leg. K. Towpasz, 11.07.1997; **29.** Książnice Małe n. Koszyce, grassland on a balk, EF5303, leg. K. Towpasz, 26.06.1999; **30.** Vicinity of Działoszyce, a gypsum sink area on a slope between Szczotkowice and Pierocice, EF3211, leg. T. Tacik, 09.08.1957 (KRAM 086091, 014848); **PPM: 31.** Stara Wieś n. Góry Mokre, xer. gras. (>10), DE6903, leg. A. Adamiec, 2006, leg. R. Piwowarczyk, 20.07.2007 (KTC); **32.** Góry Suche n. Góry Mokre, W part, NNE-facing xer. gras. and scrubs (>15), DE5923, 5933, 51˚01’45.57”N, 19˚58’24”E, 279 m, leg. R. Piwowarczyk, 03.05.2006 (KTC); **PS: 33.** SSW of Młodzawy estate in Skarżysko-Kamienna, between E roadside and a forest complex (>10), EE4630, 51˚05’19.88”N, 20˚52’33”E, 269 m, vid. Ł. Maślikowski, 2007; **34.** Piaski n. Parszów, margin of a pine forest W of Piaski (2), EE5601, 51˚05’14.3”N, 20˚55’09”E, 244 m, vid. M. Fałdziński, 2008; **PSz: 35.** Chańcza n. Raków, fallow NE of Chańcza (>5), EE9732, 50˚39’01.67”N, 21˚03’ 34”E, 239 m, vid. M. Fałdziński, 2009; **36.** NW of Szydłów, xer. gras. on a hill known as Lisi Kamień (>10), EF0710, 50˚36’10.25”N, 20˚59’35.27”E, 274 m, leg. M. Gwardjan, 2010 (KTC); **37.** Kotuszów, rye field, EF0712; leg. M. Faniczak, 19.07.1979 (KRA, 0233676); **PI: 38.** Wesołówka, fallows, balks and xer. gras. at edges of Vistula v. („Modrzywka”) (>30); FE6202, 50˚58’41.9”N, 21˚47’47.2”E, 170 m, vid. R. Piwowarczyk, 1999-2010; leg. R. Piwowarczyk, 29.06.2005, 01.08.2010 (KTC); **39.** N of Krzyżanowice, xer. gras. by a mid-field limestone excavation pit, EE3822, leg. M. Nobis, 19.07.2000 (KRA, 0318684), (Nobis 2007); **40.** 500 m N of E part of Seredzice village, EE4801, (Nobis 2007); **PJ: 41.** Between Sędziszów and Sosnowiec, xer. gras. (>10); EF0020, leg. B. Piwowarski, 28.07.2011 (KRA); **PPM: 42.** Murawy Dobromierskie res. n. Dobromierz, edge of a former excavation pit and balks (>10), DE5931, 6901, 51˚00’34.9”N, 19˚54’37.2”E, 273 m, leg. R. Piwowarczyk, 04.06.2008 (KTC); **WŁ: 43.** NNW of Skałka Polska n. Ewelinów, xer. gras. and thermophilous scrubs on a S and SW-facing hill, EE6120, 50˚57’06”N, 20˚10’03”E, 250 m, leg. R. Piwowarczyk, 09.07.2007 (KTC); **WM: 44.** Uniejów-Rędziny, a fallow between forest n. Tunel railway station and Biała Góra res., between road to Kępa and forest, fallow behind a single house, DF2913, leg. M. Bogdański, 27.07.1988 (KRA, 0171466); Tunel n. Miechów, steppe slope, leg. A. Jasiewicz, 01.07.1956 (KRAM, 414025); **45.** NEE of Kępie, xer. gras. near railway line (1 shoot), DF2903, 50˚27’37”N, 19˚57’49”E, 345 m, vid. B. Binkiewicz, 19.08.2005; **46.** Opalonki res., xer. gras., EF3112, leg.

D. Wołkowycki, 04.08.2010 (3377, private herbarium). **WS: 47.** Beszyce, xer. gras., FF0013, leg. A. Pierścińska, 23.05.2009 (KRA).

Appendix 9. List of localities of *Orobanche lutea*

GP: 1. Skowronno res. n. Skowronno Dolne, xer. gras., wastelands (<200), EF1302, 50°32'53"N, 20°29'07"E, 217 m, vid. R. Piwowarczyk, 2001-2010, leg. R. Piwowarczyk, 06.2006 (KTC); [Skowronno Dolne, leg. Z. Głowacki, 25.06.1989, WSRP, 5166]; **2.** NW of Pińczów, xer. gras. and scrubs, field margins (>20), EF1303, 50°32'06"N, 20°31'06"E, 246 m, leg. R. Piwowarczyk, 2010 (KTC); [Pińczów, grassland on a xerothermic hill, leg. M. Mazur, 07.08.1980 (KRA, 105036)]; **3.** Pasturka n. Pinczów, xer. gras., ecotone zones of xer. gras. and alfalfa fields, also in an alfalfa field (>100), EF1410, 1420, 50°30'35.79"N, 20°33'35"E, 220 m, vid. R. Piwowarczyk, 1999-2010, leg. R. Piwowarczyk, 10.06.2008, 04.06.2009 (KTC); **4.** Wełecz n. Busko Zdrój, S-facing xer. gras. on a hill by a surfaced road from Wełcz towards Siesławice (>30), EF1433, 50°28'14.92"N, 20°41'12"E, 261 m, leg. R. Piwowarczyk, 21.07.2006 (KTC); **5.** Between Kików and Sułkowice, xer. gras. on a former limestone excavation pit, n. Kamienna Góra (>20), EF2610, 2611, 50°25'05.51"N, 20°51'24"E, 268 m, 50°25'04"N, 20°51'38"E, 287 m, leg. R. Piwowarczyk, 28.05.2008 (KTC); **6.** Ostra Mt. ecol. site, S of Pęczelice, xer. gras., S-facing wastelands and field margins (>100), EF2502, 50°26'35.46"N, 20°47'06"E, 240 m, leg. R. Piwowarczyk, 28.08.2008 (KTC); [Orla Mt. n. Żerniki (probably misspelt Ostra Mt.), leg. B. Brzyski, 06.06.1957 (KRAM, 274022)]; **7.** Łagiewniki n. Busko Zdrój, S and SW-facing xer. gras. (Zimne Wody res.) (<30), EF1521, 1531, 50°28'58.72"N, 20°44'00"E, 254 m, vid. R. Piwowarczyk, A. Przemyski, 2006, leg. R. Piwowarczyk, 22.06.2006 (KTC); **8.** Czarownica Mt. n. Żerniki Górne, xer. gras. (<50), EF1532, 2502, 50°27'31.7"N, 20°47'01"E, 264 m, leg. R. Piwowarczyk, 28.08.2008 (KTC); [Żerniki, Busko Zdrój district, on chalky slopes, leg. A. Jasiewicz, 16.06.1957 (KRAM, 413638, 413637)]; **GW: 9.** Polana Polichno res., W of Młodzawy Duże, xer. gras. and thermophilous scrubs (<300), EF1331, 50°28'01.9"N, 20°28'16.7"E, 50°28'01.6"N, 20°28'15.5"E, 243 m, 50°28'02.8"N, 20°28'01.7"E, 50°28'01.9"N, 20°28'06.7"E, vid. R. Piwowarczyk, 2002-2010, leg. R. Piwowarczyk, 02.06.2007, 29.06.2009, 01.07.2010 (KTC); [in a glade known as Polichno, about 3 km W of Młodzawy, leg. J. Mądalski, 01.06.1966 (KRAM, 494801); Polana Polichno, 3 km W of Młodzawy, leg. M. Ciaciura, 01.06.1966 (KRAM, 356934); xerothermic scrubs on chalky rendzina in Polana Polichno res., leg. M. Halewska (KTC, 004094); Bróż and Przemyski 1989]; **10.** Chroberskie Forests, scrubs on forest margin, EF2323 (?), leg. ?, det. M. Kucowa, 1915-1916 (KRAM, 206795); **GŚ: 11.** Rzepka Mt. res., SW of Chęciny, xer. gras. and scrubs (<100), EE8310, 50°47'55.75"N, 20°26'53.74"E, 326 m, leg. R. Piwowarczyk, 06.2003, 14.06.2007 (KTC); **12.** Zelejowa Mt. res., N of Chęciny, xer. gras. and scrubs (>50), EE8301, 50°48'57.91"N, 20°27'44.05"E, 311 m, vid. R. Piwowarczyk, 2008; **13.** Sosnówka Mt., NWW of Chęciny, xer. gras. (>100), EE8300, 50°48'22.74"N, 20°26'01.68"E, 296 m, leg. R. Piwowarczyk, 05.2006 (KTC); **14.** Podzamcze n. Chęciny, xer. gras. on a hill, on SE forest margin, between dirt road to castle in Chęciny and buildings in Podzamcze village (>20), EE8311, 50°46'59.77"N, 20°27'25.68"E, 235 m, leg. R. Piwowarczyk, 08.06.2006 (KTC); **15.** Grzęby Bolmińskie hills, N and NEE of Bolmin, xer. gras. and scrubs, (<100), EE8201, 8202, 50°48'34.25"N, 20°21'56.09"E, 287 m, 50°49'12.26"N, 20°20'51.60"E, 306 m, leg. R. Piwowarczyk, 2008 (KTC); **16.** Gajówka, N of Milechowy village, NW part of Grzęby Bolmińskie hills, xer. gras. n. roadsides (green tourist trail) (>5), EE7231, 50°49'39.7"N, 20°20'00"E, 286 m, vid. M. Podsiedlik, 07.2009; **17.** Sitkówka-Nowiny, xer. gras. on Berberysówka Mt., EE8302, leg. D. Molendowska, 11.08.1986 (KTC), vid. R. Piwowarczyk, 2006; **18.** Gałęzice, EE7233, E. Bróż, 1993 unpubl. data; **19.** Brzeziny, xer. gras. on Stokowa Mt., SW-facing (>30), EE8420, 50°46'02.2"N, 20°35'01.3"E, 267 m, leg. R. Piwowarczyk, 2008 (KTC); **20.** Podwole n. Morawica, E of Nida Forest (Las Nidzki), EE8332, vid. M. Podsiedlik, 2008; **NP: 21.** Between Chomentówek and Sędziejowice, xer. gras. on hills known as Lipna Mt. and Śliwie, on both sides of road (<300), EF0433, 50°34'22.57"N, 20°39'45.91"E, 265 m, leg. R. Piwowarczyk, 08.06.2006, 06.06.2007 (KTC); **22.** between Sędziejowice and Gartatowice, xer. gras. on gypsum, on both sides of road (<100), EF0422, 0432, 50°34'34.25"N, 20°37'33.87"E, 237 m, leg. R. Piwowarczyk, 08.06.2006 (KTC); **23.** Between Szaniec and Zwierzyniec, xer. gras. on slopes (>200), EF1510, 50°30'43.88"N, 20°42'04"E, 250 m, leg. R. Piwowarczyk, 18.08.2006 (KTC); **NS: 24.** 6 km before Busko Zdrój, a Miocene hill with steppe flora, very close to road, EF2520(?), leg. K. Kostrakiewicz, 06.06.1957 (KRAM, 262240); **25.** Górki n. Szczerbaków, xer. gras. on S, SW and SE-facing hills on gypsum in central part of a fish pond complex (<50), EF3501, 3511, 50°20'51"N, 20°43'54"E, 174 m, 50°20'55"N, 20°44'01"E, 179 m, vid. R. Piwowarczyk, 2007 (KTC); **26.** Przęślin res. n. Chotel Czerwony, xer. gras. (>100), EF2531, 50°22'41.87"N, 20°42'59"E, 188 m, leg. R. Piwowarczyk, 15.07.2006 (KTC), [gypsum rock in Czerwony Chotel res., about 0.2 km E of Chotel Czerwony village n. Busko Zdrój, leg. J. Mądalski, 03.06.1966 (KRAM, 494780, 494802), (KTC, 002995)]; **27.** Piestrzec, roadside of a dirt road, EF2633, leg. K. Brońska, 2008 (KTC); **28.** Góry Wschodnie res. n. Chotel Czerwony, xer. gras. (>20), EF3501, vid. R. Piwowarczyk, 2008; **PP: 29.** Piotrkowice Wielkie, xer. gras. on slope of Szreniawa v., EF4121, leg. K. Towpasz, 01.06.1996 (KRA); **30.** Łubinówka n. Bejsce, field margin, EF4421, leg. K. Towpasz, 19.06.2001 (KRA); **31.** Kaczkowice n. Kazimierza Wielka, EF4430, leg. K. Towpasz, 21.06.1999 (KRA); **PPM: 32.** Murawy Dobromierskie res. n. Dobromierz, xer. gras. and scrubs, former excavation pits, scattered (<200), DE5931, 6901, 51°00'31.4"N, 19°55'15"E, 288 m, 51°00'33.9"N, 19°55'16.9"E, 307 m, 51°00'34.9"N, 19°54'37.2"E, 273 m, leg. R. Piwowarczyk, 04.06.2008 (KTC) [Murawy Dobromierskie, leg. P. Niedźwiedzki, 09.06.2006 (LOD); leg. D. Wołkowycki, 01.06.2010 (0613, private herbarium)]; **PS**, on border with **DN**: **33.** Jacłów n. Karsznice, xer. gras. and thermophilous scrubs on a mid-field escarpment (>50), EE8221, 50°45'58.6"N, 20°20'29.2"E,

227 m, leg. R. Piwowarczyk, 10.06.2008 (KTC); **PSz: 34.** Dębska Wola n. Morawica, xer. gras. and wastelands adjacent to blackthorn scrubs, S-facing (>100), EE9400, 50°42'49.2"N, 20°35'34.6"E, 292 m, leg. R. Piwowarczyk, 13.06.2009 (KTC); **35.** Morawicka Mt. n. Morawica, xer. gras. and wastelands, NE part of quarry edge (<50), EE8431, 50°44'24"N, 20°36'43.87"E, 257 m, vid. R. Piwowarczyk, 2008; **PI: 36.** Ulów res. n. Bałtów, thermophilous fringe communities on an oak-hornbeam forest margin (forest sect. 401), over 50 m S of Bałtów–Lemierze road (>10), FE5033, 51°00'06"N, 21°31'55"E, 182 m, leg. B. Maciejczak, 2007 (KTC); vid. R. Piwowarczyk, 2007, (Piwowarczyk 2010b); **37.** S and SE part of Dorotka village, xer. gras. and scrubs by a field road to Wesołówka village (<200), FE5232, 50°59'56"N, 21°47'11"E, 170 m, vid. R. Piwowarczyk, 2000-2008, leg. R. Piwowarczyk, 01.06.2002, 18.06.2006 (KTC), [also along a valley, on border between PI and MPW (Piwowarczyk 2010b, Piwowarczyk *et al*. 2011)]; **38.** 350 m S of S edge of Stoki Duże village, a SW-facing mid-field xer. gras., on E side of a field road to Ruda Kościelna (>200), FE6013, 50°56'57"N, 21°33'36"E, 163 m, leg. R. Piwowarczyk, 04.07.2004, 21.06.2005 (KTC), vid. R. Piwowarczyk, 2009, (Piwowarczyk 2010b); **39.** NE part of Wesołówka village, towards Sulejów. *O. lutea* is scattered here and forms over 10 local populations; in total over 400 specimens grow in xer. gras., wastelands, thermophilous scrubs, margins of fields and roadsides, on border between PI and MPW (Piwowarczyk 2006, 2010b, Piwowarczyk *et al*. 2011), FE6202, 50°58'49"N, 21°47'47"E; 50°58'56"N, 47°38'73"E; 50°58'27"N, 21°47'48"E, 170 m, leg. R. Piwowarczyk, 13.07.2004, 17.06.2006 (KTC), vid. R. Piwowarczyk, 1999-2010; **40.** Bandocha hills, S of Lasocin, SW-facing xer. gras. subject to secondary succession (>5) (Piwowarczyk 2010b), FE7201, 50°53'14"N, 21°45'08"E, 165 m, vid. R. Piwowarczyk, 2001 (KTC); **41.** Biedrzychów, border between PI and MPW, margin of wasteland and scrub on S-facing chalky rendzina, N of road to Lasocin (>10), FE6232, 50°54'05.91"N, 21°47'13.67"E, 186 m, leg. R. Piwowarczyk, 2008 (KTC). **WM: 42.** Opalonki res., N of Stara Wieś n. Klonów, ecotone zone of xer. gras. and a field (>5), EF3111, 50°20'58.9"N, 20°10'39"E, 333 m, vid. R. Piwowarczyk, 2008; **43.** Biała Góra Mt. res. n. Tunel, xer. gras. and wastelands (<150), DF2913, 50°26'37.2"N, 19°58'07"E, 382 m, leg. R. Piwowarczyk, 16.06.2006 (KTC), [E part of the res. and adjacent fields and fallows, a belt of grasslands and scrubs in forest sect. 132 (Binkiewicz 2009); Klonów n. Miechów, in a steppe res., association *Inuletum ensifoliae*, leg. A. Jasiewicz, 20.06.1953 (KRAM, 414022); Tunel, edge of arable field, leg. D. Wołkowycki, 02.08.2010 (6447, private herbarium)]; **44.** NEE of Kępie village, xer. gras. n. railway line (<50), DF2903, 50°27'37", 19°57'49"E, 345 m, vid. B. Binkiewicz, 19.08.2005; **45.** Jaksice, loess ravine, EF3031, leg. A. Kozłowska, 17.07. (KRAM, 242018); **WS: 46.** Dwikozy, xer. gras. N of stadium, FE8222, leg. G. Worobiec, 17.06.1991 (KRAM, 403485), vid. R. Piwowarczyk, 2006; **47.** (border between WS and MPW) Panieńska Góra ecol. site, Słupcza n. Dwikozy, S-facing slope of Vistula v., xer. gras., on loess, belonging to association *Sisymbrio-Stipetum capillatae* (>20), FE8223, 50°44'47"N, 21°47'54.3"E, 160 m, leg. R. Piwowarczyk, 06.06.2008 (KTC), (Piwowarczyk *et al*. 2009, Piwowarczyk 2010a).

Appendix 10. List of localities of *Orobanche pallidiflora*

PJ: Between Potok Mały and Mierzawa river, fallow on a field margin, on top of an escarpment (<30), EF0122, 50°35'13"N, 20°13'36"E, 234 m, leg. B. Piwowarski, 15.07.2009, leg. R. Piwowarczyk, 21.08.2009 (KTC), (Piwowarczyk *et al*. 2010).

Appendix 11. List of localities of *Orobanche picridis*

GP: 1. between Skowronno and Pińczów, ecotone zone of xer. gras. and fallows, wastelands on slopes, 2 large populations (>150, <200), EF1302, 1303, 50°32'08.3"N, 20°30'55.6"E, 247 m, leg. R. Piwowarczyk, A. Przemyski, 04.07.2006 (KTC) **2.** between Pińczów and Pasturka, xer. gras., ecotone zones of grassland and an arable field, S and SSW-facing; scattered (>50), EF1410, 1420, 50°30'35.45"N, 20°33'35"E, 219 m, 50°30'26.45"N, 20°33'57"E, 228 m, 50°30'38,52"N, 20°33'36"E, 232 m, leg. R. Piwowarczyk, 25.06.2007 (KTC); **3.** Xer. gras. E of dirt road to Żerniki Górne (>15), EF2503, 50°27'29"N, 20°47'28"E, 260 m, leg. M. Nobis, 2009 (KRA), (Nobis & Nobis 2010); **4.** Ostra Mt. ecol. site, S of Pęczelice, S-facing wastelands and field margins (>100), EF2502, 50°26'34"N, 20°47'05"E, 239 m, vid. A. Przemyski, 2010, leg. R. Piwowarczyk, 13.07.2010, **5.** Nowy Folwark, a fallow in NW part of a forest complex (>50), EF1423, 50°30'04"N, 20°41'20.8"E, 250 m, vid. P. Cieślak, 2009; **GW: 6.** Wola Chroberska, E part, xer. gras. on a steep slope, E side of dirt road (>10), EF2323, 50°23'57.3"N, 20°31'16"E, 230 m, leg. R. Piwowarczyk, A. Przemyski, 19.07.2006 (KTC); **NS: 7.** Przęślin res. n. Chotel Czerwony, S- and SW-facing xer. gras., partly grazed (>30), EF2531, 50°22'40.6"N, 20°42'59"E, 197 m, leg. R. Piwowarczyk, A. Przemyski, 05.07.2006 (KTC); **PI: 8.** Pętkowice, xer. gras. and wasteland with abundant self-sown *Pinus sylvestris* at foot of left bank of Kamienna river (>100) (Bróż *et al*. 2001; Piwowarczyk 2010b), FE5121, 51°01'03.1"N, 21°34'53.2"E, 140 m, leg. R. Piwowarczyk, 04.07.2004, 21.06.2005 (KTC); **9.** S and SE of Dorotka village, xer. gras. (>20), border between PI and MPW (Piwowarczyk 2010b, Piwowarczyk *et al*. 2011), FE5232, 50°59'56.33"N, 21°47'11.46"E, 166 m, vid. R. Piwowarczyk, 2001-2006, leg. R. Piwowarczyk, 05.2001 (KRA, 0267164), 01.06.2002 (KTC), **10.** Wesołówka n. Tarłów, fallows, field margins, and initial xer. gras., on chalky rendzinas (Bróż *et al*. 2001; Piwowarczyk 2006, 2010b; Piwowarczyk *et al*. 2011) (<600), FE6202, 50°58'36.7"N, 21°47'40.8"E, 178 m, vid. R. Piwowarczyk, 1999-2010, leg. R. Piwowarczyk, 07.1999, 13.07.2004, 01.08.2010 (KTC); **WM: 11.** Szczepanowice, S-facing xer. gras. on Kaczorowe Doły hills (2 shoots), EF3032, 50°18'25.5"N, 20°03'28.4"E,

260 m, vid. R. Piwowarczyk, 2009; **12.** Miechów, NW part, warm hill, uncultivated grassland, EF3000, leg. M. Szewczyk, 09.07.2002 (KRAM, 527156); **13.** N of Opalonki res., forest complex, n. forest path (1 shoot), EF3112, 50°21'02.49"N, 20°10'30.36"E, vid. K. Ciesielski, 07.2011; **14.** Wiktorowice n. Raciborowice, xer. gras. (>10), EF5032, leg. K. Towpasz, 17.06.1995 (KRA); **PPM: 15.** Murawy Dobromierskie res. n. Dobromierz, wasteland on margin of a pine forest and xer. gras., S-facing (>1000), DE6901, 51°00'29.7"N, 19°54'52.1"E, 303 m, leg. P. Niedźwiecki, 09.07.2006 (LOD), leg. R. Piwowarczyk, 04.06.2008 (KTC).

Appendix 12. List of localities of *Orobanche ramosa*

NS: 1. Łatanice n. Busko Zdrój, tobacco field, EF2520, leg. A. Jasiewicz, 30.09.1955 (KRAM, 413633, 413634, 413635, 413636, 019545, 088313); **PP: 2.** Zysławice n. Kazimierza Wielka, tobacco field (<50 tufts), EF5303, 50°11'25,1"N, 20°30'58,7"E, 220 m, leg. R. Piwowarczyk, 07.09.2008 (KTC).