

Orobanche caryophyllacea Sm. (OROBANCHACEAE) IN POLAND: CURRENT DISTRIBUTION, TAXONOMY, PLANT COMMUNITIES AND HOSTS

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Abstract

The paper presents the current distribution of *Orobanche caryophyllacea* Sm. in Poland based on a critical revision of herbarium and literature data as well as the results of my field studies. The majority of localities are in south and south-eastern Poland: Małopolska Upland, Lublin Upland, Roztocze, Przemyśl Foothills, Pieniny Mts, rarely in the valleys of the Lower Vistula and Oder rivers or Wolin island. The distribution map in Poland is included. The taxonomy, biology and ecology of the species are discussed.

Key words: *Orobanche caryophyllacea*, holoparasite, herbarium collections, distribution, hosts

has also been reported on *G. schultesii*, *G. glaucum*, *G. album*, *G. sylvaticum* or *G. tunetanum* from Algeria [3–5,17,20,23–25]. It prefers xerothermic habitats of the Festuco-Brometea class and fringe communities of the Trifolio-Geranietea sanguinei class, especially of the Geranion sanguinei alliance, chiefly in uplands and mountains, e.g. 1700 m in Slovakia (Bielskie Tatra Mts), up to 2000 m in Switzerland [20,24].

The aim of this study was to identify the present distribution of *Orobanche caryophyllacea* in Poland based on field investigations and verified herbarium and literature data. Preferred habitats, communities, hosts and threats are also discussed below.

INTRODUCTION

In Poland the holoparasitic genus *Orobanche* L. (Orobanchaceae) contains 19 species, including two ephemerophytes [1–19]. These taxa are protected and their majority grow at rare and threatened localities. The species chiefly occur within the belt of the Polish Uplands and in the lower Oder and Vistula valleys. *Orobanche caryophyllacea* Sm. [bedstraw (clove-scented) broomrape] is a European-western Asiatic species [20]. It occurs in Western (from France), Central and Eastern Europe, from southern England, the Netherlands, Germany, Poland, Estonia, Mediterranean Region, to Asia Minor, the Caucasus, and Iran [21]. The species has also been reported from northern Africa [22,23].

Orobanche caryophyllacea is oligophagous and parasitizes species of the family Rubiaceae and the genus *Galium*. In Central Europe, it mostly occurs on *G. mollugo*, *G. verum*, *G. boreale* and *G. odoratum*; it

TAXONOMIC REMARKS

Orobanche caryophyllacea J. E. Smith 1798, Transact. Linn. Soc. London 4: 169. Syn.: *O. vulgaris* Poiret 1798 (1. Nov.), in Lamarck, Encycl. Meth. 4: 621; *O. galii* Duby 1828, Bot. Gall. 1: 349.

Ind. loc.: “Gathered in shrubby hills near Valcimara [Valcimarra, Caldarola, Macerata Province, Le Marche Region, Italy], at the foot of the Apennines [Appennino umbro-marchigiano, Apennine Mountains], in April 1787. Tour on the Continent, vol. ii. 308. Linnaeus received the same from Siberia” [26].

Lectotype: herb. Smith 1087.23 (LINN).

In the traditional division, *Orobanche caryophyllacea* is included in grex *Galeatae* Beck, containing species having the corolla with a curved dorsal line, a galeate upper lip, large flowers, 17–35 mm, yellow-brown, purple, lilac, usually purpurescent towards the margin, with high colour variability [22,23]. The species is placed in the section *Orobanche* Teryokhin,

subsection *Galeatae* (Beck) Teryokhin [27], in the most recent approach. In Central Europe, *Orobancha lutea* and *O. teucrii* also belong to the subsection *Galeatae*. In an older approach, these species were included in grex *Galeatae* together with *O. gamosepala* and *O. latisquama* [23]. At present, the former is placed in a separate section, *Gamosepala*, [27] while *O. latisquama* has been placed in the genus *Boulardia latisquama* [28–30]. *O. clausonis* Pomel, which is classified in grex *Minores* [23], is a very similar species; however, the diagnostic characters indicate it should be included in grex *Galeatae*. It also parasitizes Rubiaceae (e.g. *Asperula hirsuta*, *Rubia peregrina*), occurring in the Mediterranean Region, mainly on the Iberian Peninsula [31,32]. A recent phylogenetic study has shown that *O. clausonis* (section *Orobancha*) is closer to the taxa of the section *Trionychon* [33].

In Central Europe, determination errors are mostly made between *Orobancha lutea* and *O. teucrii*. Unlike *O. caryophyllacea*, *O. lutea* nearly always has a wax-coloured or yellow stigma, the dorsal line of the corolla is curved from its base, slightly convex, but the corolla is not swollen and with a considerably less open throat. It parasitizes the *Medicago* genus and is scentless or the scent is very delicate. The dorsal line of the corolla in *O. teucrii* is straight or weakly convex; the inflorescence is short and with few flowers. It parasitizes species of the *Teucrium* genus. Photographs and descriptions of the species are available in several studies [20,21]. *O. teucrii* was incorrectly reported from the Polish part of the Pieniny Mts [34] and from the Lublin region [35]. The species was identified as *O. caryophyllacea* on herbarium and field verification.

Phenotypic variability of shoots is very high in *Orobancha caryophyllacea*, especially of flowers and stems, with a wide range of colours from albinotic, bright yellow, light pink and purple to violet. The colour of the pistil stigma is also variable. Typically, it is purple-coloured, but forms having orange, yellow and pink stigmas are known. The intensity of pubescence and metric characters are also observed. One population can comprise even a few colour forms. Many varieties have been described: var. *typica* G. Beck, var. *incurvata* G. Beck, var. *buhsei* (Reuter) G. Beck, var. *gymnantha* G. Beck, and over 30 lower units depending on the colour, pubescence and calyx structure [22,23]. Specimens with large flowers (2.5–3.5 mm), lax and multi-flower inflorescence, were determined in Poland, especially in Silesia, as var. *laxiflora* (= *O. laxiflora* Reichenb., f. *macrantha* (Dietrich) G. Beck), while specimens with a lemon-coloured corolla and a purple pistil stigma from the area of Krynica were determined as f. *citrina* (Dietrich) G. Beck [36]. Specimens having a lemon-coloured corolla and a pistil stigma can also be infrequently observed in the Nida Basin (e.g.

Sędziejowice), corresponding to the described form f. *strobiligena* (Reichenbach) G. Beck. Intensely-coloured purple individuals, described as f. *orphinia* G. Beck, can also be encountered in the same populations at scattered localities in Poland. Albinotic specimens have also been observed in shaded sites, such as the specimen in the Grabowiec reserve in the Nida Basin [5]. An albinotic form was described as f. *albiflora* Baguet and reported so far from Belgium [23].

MATERIALS AND METHODS

Field research was conducted in 1999–2013, with the investigations being intensified between 2006 and 2013. All the herbarium materials of *Orobancha caryophyllacea* available in Poland were reviewed. The materials are deposited in the herbaria CHRZ, KRA, KRAM, KTC, KTU, LBL, LOD, OPOL, POZ, TRN, UGDA, WA, WRSL, WSRP, and also in Germany (B, GLM). Herbarium acronyms are given after Mirek et al. [37] and Holmgren and Holmgren [38]. The nomenclature of vascular plants follows Mirek et al. [39]. The nomenclature of syntaxa is based on Matuszkiewicz [40]. The localities are organized as ATPOL cartogram units, 10 km × 10 km [41, see <http://www.ib.uj.edu.pl/chronopol/>], in alphabetical order. Probably incorrect localities or not confirmed by the field or herbarium investigations are marked with the symbol “?” per square number. The localities are described as follows: ATPOL grid unit, geographic location, habitat description, abundance in brackets. The following information is also given for most localities: geographic coordinates and altitude (above sea level), and for revised exsiccata the collector and collection date, exsiccatum number and the herbarium acronym.

Host plants were observed by delicately exposing the soil with a gardening shovel. A total of 80 soil pits were observed in the field and in the analysis of herbarium materials containing an attached host.

Symbols and abbreviations: ecol. site – ecological site, leg. – collected by, n. – near, phot. – photography, res. – reserve, v. – valley, xer. – xerothermic, gras. – grassland, vid. – seen by, ? – doubtful, uncertain, or unconfirmed locality.

RESULTS

Distribution in Poland

In Poland *Orobancha caryophyllacea* occurs mainly in the Małopolska Upland (chiefly the Nida Basin and the Middle Vistula River valley), Lublin Upland, Roztocze, Przemyśl Foothills, Sudeten Foreland and Silesian Basin, the valleys of the Lower Vistula and Oder Rivers, Wolin island, and Pieniny Mts (Fig. 1). Frequent determination errors were made in the past

and the list below presents only verified data. As my verification showed, the species was incorrectly reported from the Silesian – Krakow Upland [e.g. 42–46, unpublished data from the ATPOL database]. It was most often mistaken with *O. lutea* and *O. kochii*, which often occur in the area, infrequently with *O. bartlingii* and *O. elatior* [47,48]. Many incorrect reports also concerned the Małopolska Upland and adjacent areas [e.g. 49–53, unpublished data from the ATPOL database]. Some literature data could not be verified as the herbarium material was lacking or despite investigations in the field (especially old German data, with not strictly defined localities). These uncertain data are marked with a special symbol on the map (Fig. 1). Attempts are still made to find and verify many of them in the field.

List of localities: **AB: 22?** – Przytór n. Świnoujście [54]; **23** – Western Pomerania, Wolin island, Wicko, sandy fallow land on Trzciągowska slopes v., leg. H. Piotrowska, 21.06.1962 (UGDA/Wolin 002); **32** – Wolin, Lubin, SW slope of an insolated hill, leg. B. Chmielewski, P. Szkudlarz, 31.05.1985 (POZ); Lubin, on the side of Główna street, thermophilous slope of the Szczecin Lagoon, 53°51'49"N, 14°26'08,02"E, 50 m, (>30), vid. R. Piwowarczyk, 08.07.2012, [54]; **33** – Trzciągowo, NE of Wapnica, vid. B. Kasperkowicz, 2010, [54]; Wapnica, chalk mine [54]; road side in a mixed coniferous forest, by the blue tourist trail, S of Turkusowe lake, 53°52'29,4"N, 14°26'25,1"E, 54 m, (2), vid. R. Piwowarczyk, 09.07.2012; Wolin island, cliff on the Szczecin Lagoon, leg. H. Piotrowska, 15.07.1951 (UGDA/Wolin 001); Wapnica, sunny gorge, leg. H. Piotrowska, 18.06.1976 (UGDA, 01/04); Dargobądz [54]; Kępa [54]; **96?** – Stargard Szczeciński and Ulikowo [55–57]; **AC: 05** – Grędziec on Miedwie lake, xer. slope, leg. J. Stasiak, 01.06.1971 (UGDA, 01/03); Grędziec, Pyrzyce district, steppe “Brodogóry” res., on a sunny slope, leg. W. Gugnacka, 29.05.1973 (TRN), [55,58–60]; roadside escarpment by the Pyrzyce-Stargard Szczeciński road [61]; **06** – “Stary Przylep” res. between Stary Przylep and Janowo villages, xer. gras., 53°11'27,25"N, 14°59'33,5"E, 80 m, (<5), vid. R. Piwowarczyk, 25.06.2009, [58,62]; **12?** – Widuchowa [60]; **15?** – Pyrzyce (Pyriz) [56]; **16?** – Zaborosko, E. Ćwikliński, unpubl, 1979 (after ATPOL); **21** – Krajnik (Kränig), leg. R. Schulz 1903, 1908 (B), [63,64]; Krajnik Dolny, xer. gras. in the SE part of Górki Krajnickie, n. an excavation pit, 53°01'35"N, 14°18'37,9"E, vid. K. Barańska, P. Pluciński, R. Piwowarczyk, 25.06.2009, [60]; Raduń, leg. R. Schulz 1908, (B), [60,63–65, vid. S. Rätzel, 2010 oral com.); **22?** – Nawodna [60]; **30** – Bielinek on the Oder river, Chojna district, leg. J. Schädle 1847, 1850, leg. R. Schulz 1911, 1914 (B), [63], leg. F. Celiński, 28.05.1971 (KTU, 1057); “Bielinek” res. on the Oder river, leg. Exc. Inst. Bot. U. P., 06.1952 (POZ); Bielinek, xer.

gras. leg. H. Piotrowska, 25.05.1967 (UGDA 01/01, 01/02), vid. R. Piwowarczyk, 07.09.2007 (<15), [64,66–75]; Bielinek-Lubichów Dolny [68]; Markocin [68]; Świerkocin [76]; **31?** – Krzymów [60]; **41** – Stare Objezierze, grassland NE of the village, between the margin of a pine forest and a lake, 52°52'43,3"N, 14°21'37,6"E, 71 m, (<5), meadow with *Arrhenatherum elatius* on the margin of a coniferous forest, 52°52'47,2"N, 14°21'30,7"E, 65 m, 52°52'53,6"N, 14°21'33,7"E, vid. K. Barańska, P. Pluciński, R. Piwowarczyk, 25.06.2009; Dolsko, xer. gras. SW of the village towards Górka lake, 52°53'38,6"N, 14°21'32,7"E, 66 m, vid. K. Barańska, P. Pluciński, R. Piwowarczyk, 25.06.2009; Żelichów, slope SE of the village (>40), [77]; Moryń (Mohrin) [64]; **66?** – Łupowo [60]; **67?** – Gorzów Wielkopolski (Landsberg): Ruski Stawek (Schützensee) [64]; Wieprzyce [60]; **68?** – Czechów (Zechow) n. Gorzów Wielkopolski [64,78]; **83** – Górzycza, Kostrzyn on the Oder river district, leg. W. Żukowski, 27.05.1962 (POZ); Górzycza (Göritz): Góra Pamięcińska (Frauendorfer Berge), [64,79]; Owczary on the Oder river, on a sunny slope overgrown with xer. vegetation, leg. W. Gugnacka, 29.05.1973 (TRN); Owczary, in a ravine, on a slope, leg. W. Gugnacka, 29.05.1973 (TRN); Owczary, xer. gras., 52°28'23,9"N, 14°38'43,1"E, 39 m, (<10), vid. R. Piwowarczyk, 25.06.2009, [80]; **BC: 76?** – Szamotuły (Master) [81]; Piaskowo [82]; **BD: 52?** – Sławskie lake n. Sława Śląska [83]; **81** – Dalków, Kurów Wielki (Dalkau, Kauer), leg. Joachim, 26.06.1888 (auch Pinkwart, 07.1899) (WRSL); Kurów Wielki (Gr.-Kauer) n. Głogów [84,85]; Śrem (Schrien) n. Głogów [85]; **82** – Niełubia (unweit des Nilbauer Birken), leg. Klopfer, 14.08.1928 (WRSL), [86]; **83** – Ogorzelec, Głogów district, in a gras., leg. Z. Głowacki, 11.06.1972 (WSRP, 00005165); xer. gras. WWN Ogorzelec (>30), vid. E. Szczeńniak, 2011 (phot.); Lower Silesia, Dalkowskie hills, Szczyglice n. Głogów, on an insolated slope SE of the village in a gras. of the alliance *Koelerion glaucae*, leg. E. Kozioł, 21.05.2005 (KTU, 99017); Szczyglice (Sieglitz) n. Głogów, 15.07.1871 leg. ? (WRSL), [84,85]; **BE: 16** – Stary Wołów, Wrocław province, sunny slope, leg. E. Kozioł, 17.06.1981 (WRSL); **67** – Górzycze (Gurwitz) n. Wrocław, leg. H. Scholtz (WRSL), [84 (var. *laxiflora*), 85,87]; **77** – Winna Góra (Weinberg) n. Sobótka (Zobten), leg. R. Sadebeck, 06.1840 (WRSL), Winna Góra n. Sobótka [84,85]; Nasławice, xer. gras. and the area around the quarry on a serpentine hill, so-called Kamienny Grzbiet, Szczeńniak unpubl 1997 (after ATPOL), (<300 in 2001), [88], (<80 in 2011), 50°53'00,0"N; 16°49'50,8"E, 174 m, vid. R. Piwowarczyk, 14.07.2011; **87** – Jasinek n. Niemcza (Johannistal), at present Góra Cierniak (Ostseite des Dörner berges), leg. T. Schube, 14.06.1914 (WRSL), [89]; **88** – Prusy, between Niemcza and Strzelin, on

G. mollugo, 06.1856, leg. R. Uechritz (WRSL); Janowiczki (Klein Johnsdorf) n. Niemcza (Nimptsch), on *G. verum*, var. *laxiflora*, leg. Schumann, 05.06.1880 (WRSL), [84,85]; Księginice Wielkie (Gr. Kniegnitz) n. Niemcza [84]; **97** – Niemcza, bank of the Ślęza river, behind the hospital, abundant (Loheufer hinter dem Genesungsheim in grossen Zahl), 14.06.1935, leg. Frömsdorf; Niemcza (an den Ohleabhängen bei Nimptsch) [90]; Stasin (Pangel) near Niemcza [85]; **CB: 99?** – Chełmno (Kulm) [81,91–93]; Chełmno, area of the Fryba river [94–96]; **CC: 08** – between Kielpand Płutowo, on *G. verum* [92,95,96]; Płutowo, leg. A. Kozłowska, 06.1927 (KRAM, 241975); Płutowo, slope, leg. M. Ceynowa, 07.06.1958 (TRN); “Płutowo” res., (3), vid. R. Piwowarczyk, 10.09.2004; (6) vid. S. Kusz, 02.06.2013; Św. Wawrzyniec Mt in Starogród n. Chełmno (Althausen am Lorenzberge) [92,95–97]; “Góra Św. Wawrzyńca” res., xer. gras. (<5), 53°19'37,5"N, 18°22'57,9"E, 92 m, vid. R. Piwowarczyk, 29.05.2009; Szymborno, Chełmno district, leg. M. Ceynowa, 29.07.1961 (TRN), [97]; **18** – slope n. Unisław, NWW of Na Skarpę street (4), vid. S. Kusz, 15.06.2013 (phot.); **39?** – Gajtowo (Getau), between Solec and Toruń [96,98]; Toruń, Dybowo (Niedermühl) [96]; **58?** – between Ściborze and Orłowo [96]; **67?** – Inowrocław [81]; Inowrocław, Niedermühle [96]; **68?** – Jaronty [96]; **75?** – Mogilno [81]; Mogilno/Wieczanowo [82,96,98]; **85?** – Trzemeszno n. Poznań [99]; **CE: 90** – Przeworno n. Strzelin (Im Prieborner Marmorbruch), marble quarry, leg. F. Wimmer, H. Grabowski, 18?? (WRSL), [84,85,100,101]; **95?** – Opole (Oppeln, bei dem Salzmagazin), [100], probably *O. lutea*; **CF: 16?** – Kamień Śląski (Grosstein), [100], probably *O. lutea*; **45?** – Borzysławice (Borislawitz) near Pawłowiczki (Gnadenfeld) [84,85]; **59** – Rudy (Rauden), leg. Dziatko, 02.07.1897 (OPOL, P/3468); **65** – Kietrz (Katscher), Gipsowa Góra (Gypsgruben), leg. Kelch (GLM-DB, 138814), leg. E. Kozioł, 15.06.1983 (WRSL, 96785), [84,85,101]; Kietrz, sunny slope, leg. E. Kozioł, 15.06.1983 (WRSL, 90811); Dzierżysław n. Kietrz, xer. gras. on gypsum areas, leg. Kelch, 1840 (GLM, 138823), leg. ?, 14.06.1859, on *G. verum* and *G. mollugo* (GLM, 106750), leg. Z. Dzwonko, A. Frey, 23.06.1970 (KRA, 066868); “Gipsowa Góra” res., Dzierżysław n. Kietrz, leg. A. Sendek, 14.05.1972 (KRA, 0138562); leg. A. Sendek, 14.06.1972 (KTU, 10554), [102]; Gipsowa Góra n. Kietrz, leg. K. Rostański, 01.06.1985 (KTU, 99029); leg. B. Fojcik, 01.06.1990 (KTU, 99030); leg. M. Buchalik, 05.06.1999 (KTU, 99027); leg. L. Dudek, 14.06.1972 (KTU, 16210), [103,104]; Kozłówek (Kösling) n. Kietrz, var. *laxiflora*, leg. M. Wetschky, 06.1876, 18.05.1904 (1907?) (WRSL), [85,105]; **DA: 80?** – Gdańsk [96]; **87?** – Frombork (Frauenburg) [106]; **96?** – Kikoły (Kickelhof) (vicinity of Janówek at present) between Kadyny (Cadinen) and Tolkmicko (Tolkemit), by the road, [92,95,96]; **DB: 71** – Bingsberge hills (at present Góry Łosiowe Mts) between Zakurzewo (Sackrau) and Wełcz (Wolz), on *G. mollugo* [92,94,95]; Grudziądz, Zakurzewo, Bingsberge, leg. Peil, 15.06.1880 (TRN), [96]; **81** – Grudziądz (Graudenz) [81], meadows on the high bank of the Vistula, SW of the fortress [92], on *G. mollugo* and *G. verum*, Grudziądz, fortress, leg. Grütter, 03.07.1887 (WA, 33086) [94–96]; **DF: 78?** – Jurczyce [107]; **88?** – Wola Radziszowska [107]; **DG: 00?** – Cieszyn (Teschen) [85]; **EC: 94?** – Modlin [108]; **EF: 04** – between Chomentówek and Sędziejowice, xer. gras. and thermophilous scrub on S- and SW-facing hills on the E and W side of the road (<200 in 2007; <100 in 2013), 50°34'23"N, 20°39'44"E, 264 m, vid. R. Piwowarczyk, A. Przemyski, 2007, vid. R. Piwowarczyk 30.05.2013, leg. R. Piwowarczyk, 06.06.2007, 04.06.2009 (KTC), [5]; Gartatowice, E part, xer. gras., on gypsum, on both sides of the road (<100), 50°34'34"N, 20°37'33"E, 237 m, vid. R. Piwowarczyk, A. Przemyski, 2007, leg. R. Piwowarczyk, 06.06.2007 (KTC), [5]; a quarry in Borków, leg. ?, 2001 (KTC); Samostrzałów, SSE part, xer. gras. (<100), 50°35'18"N, 20°38'41"E, 244 m, leg. R. Piwowarczyk, 04.06.2009 (KTC), [5]; **14** – Pasturka, in a hole remaining after excavated stone on the forest margin, leg. J. Mądalski, 03.06.1966 (KRAM, 494810); oak-hornbeam forest in the W part of the “Grabowiec” res. between Gacki and Bogucice I (<100). The species parasitizes *G. odoratum*, *G. mollugo*, *G. verum* and *Cruciata glabra* there (>50), 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), vid. R. Piwowarczyk, 2012, [5,53]; “Grabowiec” res. n. Krzyżanowice, gras., leg. A. Jasiewicz, 07.06.1957 (KRAM, 414019); Bogucice, Grabowice (probably the “Grabowiec” res.), leg. K. Kaznowski, 13.06.1931 (POZ); res. Bogucice, leg. S. Chrościelewska, 15.07.1935 (WA, 000028406=018860); **15** – Łagiewniki n. Busko-Zdrój, xer. gras., S and SW-facing (“Zimne Wody” res.) (<50), 1531, 50°28'58,72"N, 20°44'00"E, 254 m, leg. R. Piwowarczyk, 21.07.2006 (KTC), [5]; Dobrowoda [109]; Czerwony Chotel [109,110], Busko-Zdrój [110]; **24** – Skorocice n. Busko Zdrój, gypsum rocks, leg. A. Jasiewicz, 07.06.1957 (KRAM, 414009); **26** – between Kików and Sułkowice, xer. gras. on a former vast limestone excavation pit (so-called Kamienna Góra), (>200), 50°25'05,51"N, 20°51'24"E, 258 m, 50°25'04"N, 20°51'38"E, 287 m, leg. R. Piwowarczyk, 28.05.2008 (KTC), vid. R. Piwowarczyk 30.05.2013, [5]; Sułkowice [111]; **27** – xer. gras. by the Piestrzec – Biechów road junction (>5), leg. A. Przemyski, 08.2008 (KTC); **34** – Wiślica, W part, xer. gras. and scrub on a S, SE and SW-facing slope (<50), 50°21'01"N, 20°39'50"E, 171 m, leg. R. Piwowarczyk, A. Przemyski, 08.2006 (KTC), [5,110]; **35** – Górki n. Szczerbaków, xer. gras. on a slope on gypsum, S, SW and SE-facing (>100), 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), vid. R. Piwowarczyk 30.05.2013, [5]; **86?** – Janowice, on a dry meadow on a steep slope on the Dunajec river [112]; **EG: 14?** – Góra Chełm, Kałłowa [113]; **17?** – Chełmiecka Góra [36, vid. 06.1916]; **32** – Pieniny Mts, between Macelak and an unnamed peak towards the Szopka pass, by the trail near a group of trees (*Galium, Laserpitium*), leg. W. Gugnacka, L. Rutkowski, 14.06.1983 (TRN); Macelak, N slopes, (5), 49°25'14"N, 20°22'32"E, 840 m, vid. I. Dembicz, Ł. Kozub, 03.07.2013 (phot.); Kozia Góra 790 m, Origano-Brachypodietum [114]; Kozia Góra, warm meadow, (<15), vid. R. Piwowarczyk, 23.07.2010, 49°25'15,6"N, 20°22'09,4"E, 791 m; Kozia Góra, SW-facing roadsides, (<20), 49°25'13,1"N, 20°22'21,4"E, 822 m, vid. R. Piwowarczyk, 23.07.2010; **33** – Pieniny Mts [115], Pieniny Mts, woody scrub, leg. Wołoszyn, 07.1928 (KRA, 012171); Pieniny Mts, leg. R. Kobendza, 1926 (WA, 0000028444=018927); Pieniny Mts, leg. A. Jasiewicz, 24.06.1952 (KRAM, 414023); cfr. Pieniny Mts, rocks on the Dunajec river, leg. M. Wayda, 23.06.1994 (KRA, 0128530); Pieniny Mts, Białe Skały, beech forest on S slopes, leg. A. Jasiewicz, 25.06.1964 (KRAM, 414020, 095244); forest below Białe Skały, leg. E. Koteja, 196? (KRAM, 363773), [34]; Ociemny Potok, on the upper side of the green trail, Fagetum carpaticum, leg. K. Zarzycki, 1965 (KRAM, 363778, 363779); Ociemny Potok (Pieniński), in the Carpathian beech grove on *G. odoratum*, leg. K. Zarzycki, 26.06.1966 (KRAM, 363771), [34]; Pieniny Mts, thermophilous beech groves below Czerwone Skały, towards the Pieniński Potok stream, 500 m a.s.l., leg. K. Zarzycki, 08.06.1966 (KRAM, 363772); Potok Pieniński [116]; Potok Pieniński, below the Limerczyki glade, Phyllitido-Aceretum, leg. E. Koteja, 07.1963 (KRAM, 363775), [34]; Potok Pieniński, below Czertezik, on grass in scrub, leg. A. Jasiewicz, 24.06.1952 (KRAM, 414010); by the bank of the Pieniński Potok stream, opposite Ociemny Wierch, meadows, leg. A. Jasiewicz, 07.07.1953 (KRAM, 414028); scrub below the Pieniński Potok stream, leg. Szajna, 10.05.1930 (KRAM, 180355), [117]; scrub on rocks below the Pieniński Potok stream, leg. K. Piech, 09.06.1930 (KRAM, 2200105); Dolina Czarnego Potoku valley, 650 m, cleared patch with *Calamagrostis varia*, leg. K. Zarzycki (KRAM, 363769), as *O. teucrii*; Sokolica [116]; beech forest below Sokolica, leg. K. Piech, 09.06.1930 (KRAM, 220106); Trzy Korony, leg. Szajna, 09.05.1930 (KRAM, 180356); Trzy Korony, grass near the summit, leg. K. Zarzycki, 02.07.1967 (KRAM, 363776); scree below Okrąglica [118]; Okrąglica, 49°24'56,9"N, 20°25'20"E, 947 m, vid. R. Piwowarczyk, 30.07.2009, 22.07.2010; 07.2012, [4]; Orlica, on grass on the Dunajec, leg. A. Jasiewicz, 24.06.1952 (KRAM, 414024), as *O. teucrii*; behind the „Orlica” hostel n. Szczawnica, meadow (<15), leg. R. Piwowarczyk, 01.08.2009, 49°25'04,6"N, 20°27'35,1"E, 505 m; Góra Zamkowa, grass near pines by the summit, on *G. mollugo*, leg. K. Zarzycki, 13.07.1967 (KRAM, 363774), [34]; small mid-forest meadow on the slope of Góra Zamkowa by the Potok Pieniński stream, leg. K. Kostrakiewicz, 24.06.1952 (KRAM, 241650); in scrub on Góra Zamkowa, leg. J. Nowak, 19.07.1954 (CHRZ); grass and scrub n. castle ruins, (2), 49°25'12,5"N, 20°25'12,9"E, 724 m, vid. R. Piwowarczyk, 30.07.2009; Pieniny Mts, „Górka” n. Długi Gronik, meadow with *Brachypodium*, leg. E. Kotejowa, 15.06.1967 (KRAM, 363776, 363777); warm meadow n. Długi Gronik, (<5), 49°25'08,2"N, 20°26'56,6"E, 515 m, leg. R. Piwowarczyk, 20.07.2010, [34]; Łażne Skały, meadow, vid. W. and L. Frey (phot.), 2009 (<30), on *G. mollugo*; between Krościenko and Tylmanowa [119]; Stajkowa Góra over Krościenko, on the Dunajec on the Dunajec SW, dry meadow, 670 m, leg. K. Stawowczyk, 09.06.2009; thermophilous grass S of an unnamed rock, 872 m, N of Cyrylowa Skała, leg. K. Zarzycki, 13.06.1966 (KRAM, 363780); Łączana, n. Przełęcz Trzy Kopce, small hill N of the trail, (<10), 49°25'08,4"N, 20°23'12,7"E, 780 m, vid. R. Piwowarczyk, 23.07.2010; Nowa Góra 850 m, Origano-Brachypodietum [114]; Kras 460 m, Origano-Brachypodietum, [114, as *O. lutea*]; Polana Pieniny Mts, 940 m, *Veratrum lobelianum-Laserpitium latifolium*, [114, as *O. lutea*]; Polana Zaosice, 630 m [120, as *O. alba*]; Wąwóz Gorczyński gorge (Macelowy) [121]; Facimiech [122]; **Slovakia:** Małe Pieniny Mts, immediately past the Slovak border, by the yellow tourist trail descending to Leśnica and diverging from the blue ridge trail between Szafranówka and Bystrzyk, vid. W. and L. Frey, 02.07.2006 and 2008; Wylizana Mt, by the blue trail, S-facing, 49°24'49,8"N, 20°27'12,3"E, 447 m, vid. R. Piwowarczyk, 01.08.2009; **34** – Małe Pieniny Mts, “Wąwóz Homole” res., grass on a rock slope, leg. B. Wójcikiewicz, 27.06.1973, 12.07.1973 (KRA, 71416, 71417); “Wąwóz Homole” res., Grass at the foot of rocks over less than 100 meters to the left of the entrance, W-facing, (<10), 49°24'20,1"N, 20°32'52,4"E, 568 m, vid. R. Piwowarczyk, 31.07.2009; Wąwóz Homole on the west slope of the gorge, rock grassland, E-facing, 49°24'16,6"N, 20°32'51,9"E, 560 m, vid. R. Piwowarczyk, 31.07.2009; **37?** – Krynica [36,123], var. *citrina*; Kopciowa [36,123], var. *citrina*; **44** – Wysokie Skałki, summit [124]; Wysoka Mt, summit, rock grassland, (>5), 49°22'49,4" N, 20°33'20"E, 1050 m, vid. R. Piwowarczyk, 31.07.2009; **46?** – Mikowa n. Muszyna [36]; **FC: 97?** – Drohiczyn [125]; **FE: 13** – Vicinity of Puławy, on hillsides, leg. A. K. Simionow, 06.1887 (WA, 000002845= 018925), Włostowice near Puławy [126]; **23** – Mięćmierz n. Kazimierz Dolny, grassy chalky slope, leg. H. Przychodzeń, 19.06.1980 (LBL); xer. gras., Mięćmierz, Albrechtówka (>5), vid. R. Piwowarczyk, 04.06.2011; **27** – Rury, Lublin, gorges, leg.

- H. Koporska, 06.1916 (LBL); **28** – Sobianowice n. Lublin, loess slope, leg. D. Fijałkowski, 09.06.1949 (LBL); sunny loess slopes, leg. D. Fijałkowski, 30.05.1959 (LBL); Długie n. Lublin, loess slope, leg. D. Fijałkowski, 03.06.1949 (LBL); Lublin, a gras. belonging to *Thalictrum-Salvietum pratensis* association on a high baulk on the slope of the Bystrzyca valley (>10), 51°16'23"N, 22°37'57"E, leg. A. Rysiak, 2006 (LBL); **52** – Ciszyca Kolonia, xer. gras. by the edge and on the SE-facing slope of the Vistula v. (>100), 51°01'08"N, 21°46'38"E, 153 m, leg. R. Piwowarczyk, 25.07.2001, 01.06.2002, 21.06.2005 (KTC), [1,3,5,17,127]; Dorotka n. Tarłów, xer. gras. and scrub N, S and SE of Dorotka, S, SE and SW-facing (<30), 51°00'02"N, 21°47'05"E, 148 m, leg. R. Piwowarczyk, 01.06.2002, 18.06.2006 (KTC), [1,3,5,17,127]; **59** – Kolonia Żuków n. Krzczonów, a partly forested xer. gras. n. a closed limestone quarry (>5), 51°02'15"N, 22°47'40"E, vid. P. Chmielewski, 17.08.2009, [17]; **62** – Wesołówka, NNE part, S-facing wasteland on chalky rendzina (>15), 50°58'37"N, 21°47'49"E, vid. R. Piwowarczyk, 1999–2006, [1,3,5,17,127,128], it did not occur in 2008–2013; Słupia Nadbrzeżna [50,129], SE-facing xer. gras., 250 m NW of the church (>10), vid. R. Piwowarczyk, 2001, 2005; [*O. caryophyllacea*: Biedrzychów reported in the literature [129]; literature data verified in the field, a locality of *O. lutea* recorded, leg. R. Piwowarczyk, 2007 (KTC); Bałtów [51,126], a locality of *O. alba* recorded, leg. R. Piwowarczyk, 24.06.2007; "Ulów" res. [130], a locality of *O. lutea* recorded, vid. R. Piwowarczyk, 2007]; Popów n. Józefów, xer. gras. on a chalky slope, leg. M. Kucharczyk, 30.06.1980 (LBL); **68?** – Wysokie n. Turobin [126]; **73** – Opoka n. Anopol on the Vistula, xer. gras. on a chalky slope, leg. M. Kucharczyk, 26.06.1980 (LBL); **82** – Dwikozy ecol. site, Dwikozy n. Sandomierz, N of the stadium, xer. gras. on the S-facing slope of the Opatówka river v. (>20), 50°44'20"N, 21°47'03.9"E, 174 m, leg. R. Piwowarczyk, 27.07.2006 (KTC), [5,17,50,131]; Dwikozy n. Sandomierz, (on *G. mollugo*) leg. R. Kobendza, 05.1930 (WA, 0000028402=018858), [5]; **GD: 23?** – Bohukały n. Terespol, xer. gras. [132]; **GE: 23** – Stawska Góra n. Chełm, summit of a chalky hill, leg. K. Izdebski, 10.07.1958 (LBL); Łęczycza-Włodawa lakeland, "Stawska Góra" res., leg. B. Chwastowski, 08.06.1978 (KRAM, 455835); Chełm district, leg. M. Hempel, 1880 (WA, 0000028404 (10898)); **55/56** – Kolonia Teresin, xer. gras. and roadsides on chalky rendzinas on a hill ca 0.5 km S of the village (>50), 50°59'21"N, 23°41'56"E; 50°59'14"N, 23°42'20"E; 50°59'20"N, 23°41'30"E; 50°59'00"N, 23°40'46"E, vid. P. Chmielewski, A. Cwener, R. Krawczyk, 2005, leg. P. Chmielewski, R. Piwowarczyk, 15.07.2006 (KTC), [17]; Teresin, along the margins of a small forest n. Teresin farm, leg. F. Karo, 29.06.1883 (WA, 0000028413=018891); **56** – Strzelce (near Białopole) in Hrubieszowski district, leg. K. Łapczyński, 20.07.1870 (WA, 0000028399=018863); **61/62** – Tarnogóra, gras. belonging to *Thalictrum-Salvietum pratensis* association in the escarpment complex in the Wieprz v. (>15), 50°53'47"N, 23°07'10"E, leg. A. Cwener, 24.06.2008 (LBL), [17]; **62** – Dworzyska, E-facing steep slopes of the Wieprz v., an overgrowing *Thalictrum-Salvietum pratensis* association (<20), 50°55'47"N, 23°08'38"E, leg. A. Cwener, 09.06.2008 (LBL), [17]; **64** – Skomorochy Małe n. Grabowiec, chalky slopes, leg. D. Fijałkowski, 14.06.1958 (LBL); Hajowniki (Reforma), xer. gras. and scrub on the chalky slope of the Wolica v., on the northern side of the Skierbieszów – Grabowiec road (>50), 50°50'26"N, 23°26'35"E, leg. A. Cwener, 22.06.2007 (LBL), [17]; **67** – Szpikołosy n. Hrubieszów, scrub of a loess slope, leg. D. Fijałkowski, 13.06.1958 (LBL); **72** – Złojec, a xer. gras. belonging to *Thalictrum-Salvietum pratensis* association on a midforest hill in the Łabuńka v., ca. 300 m N of the village church (>30), 50°46'55"N, 23°07'12"E, vid. W. Michalczuk, 17.06.2006, [17]; **77** – Czumów n. Hrubieszów, loess slope, leg. D. Fijałkowski, 20.06.1955 (LBL); **81?** – Szczebryzyna [108]; Dziewcza Góra S of Niedzieliska [133]; **82** – Kąty n. Zamość, clearing in an oak forest on rendzina, leg. D. Fijałkowski, 05.06.1955 (LBL); oak forest on chalk, leg. D. Fijałkowski, 29.06.1951 (LBL); sunny chalky hill, leg. D. Fijałkowski, 04.06.1959 (LBL); Kąty II, xer. gras. adjacent to a dirt road from the Wymysłówka village to Wychody, on a midfield hill known as Wieprzecka Góra (>50), 50°40'22"N, 23°07'22"E, leg. R. Piwowarczyk, W. Michalczuk, P. Chmielewski, 15.07.2006 (KTC), [17]; Hubale, xer. gras. on a calcareous hill, ca. 0.5 km N of the village (>15). The locality was partly damaged by ploughing in 2009. 50°41'07"N, 23°09'47"E, vid. W. Michalczuk, 2007, [17]; **94** – Łabunie n. Zamość, forest glade on chalk, leg. D. Fijałkowski, 15.07.1957 (LBL); **96** – Dobużek, "Skarpa Dobużańska" res., ca. 1 km NW of the Dobużek village, on the steep slope of the Huczwa v., xer. gras. belonging to *Thalictrum-Salvietum pratensis* association, on chalky rendzina and chernozems (>50), 50°34'50"N, 23°42'55"E, leg. P. Chmielewski, R. Piwowarczyk, 12.07.2006 (KTC), [17]; **GF: 07** – Posadów, xer. gras. on embankments of an early medieval earthwork, on the edge of the Kamionka v., ca. 0.5 km N of the village (>30), 50°30'27"N, 23°48'57"E, vid. E. Gorgol and P. Chmielewski, 24.05.2009, [17]; **14?** – Biała Góra n. Tomaszów [126]; **15** – Przecorsk, xer. gras. on the Łysa Góra hillside and on the bottom of a dry small v. joining the Sołokija river (>50), 50°25'27"N, 23°31'06"E, leg. P. Chmielewski, R. Piwowarczyk, 09.06.2007 (KTC), [17]; **25** – Machnów Stary, overgrowing xer. gras. in the „Machnowska Góra" res. (>10), 50°22'06"N, 23°35'18"E, vid. P. Chmielewski, R. Piwowarczyk, 13.07.2006, [17]; **80?** – Winna Góra n. Przemyśl, S slope; ravine behind the Drużbacki farm [134]; **90** – Przemyśl, Grochowska street, dry roadside, leg. M. Wolanin, 05.06.2009 (KRA).

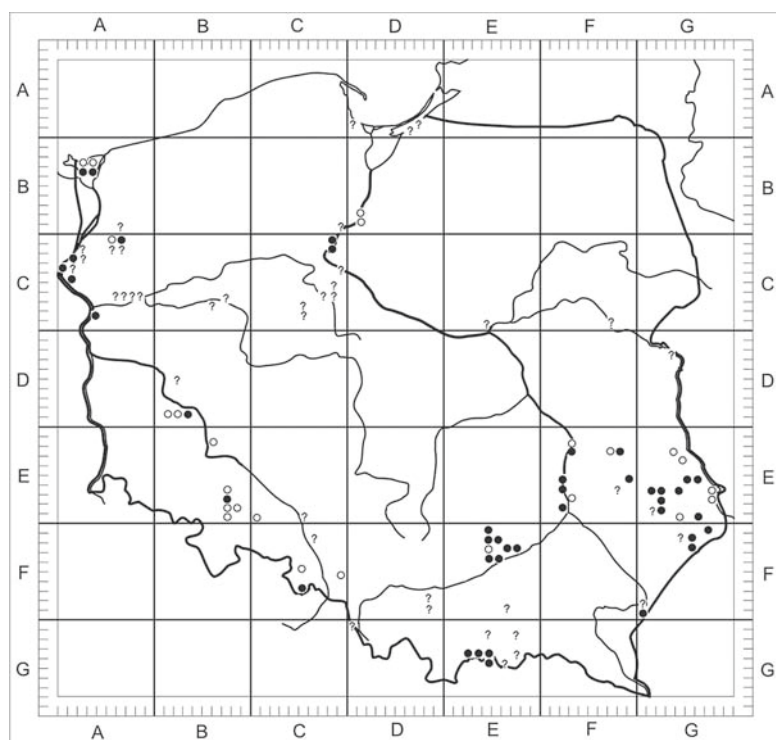


Fig. 1. Distribution of *Orobanche caryophyllacea* in Poland: ● – localities confirmed after 2000; ○ – localities documented with herbarium collections, not confirmed after 2000; ? – localities not confirmed in the field, uncertain or probably doubtful, lack of herbarium materials.

Host preferences

Prior to my study, *Orobanche caryophyllacea* was reported from Poland as a parasite of the Rubiaceae family, genera *Galium*, *Asperula* and *Sherardia* [135]. A total of 80 soil pits were investigated in the field between 2006 and 2013. Herbarium materials were analyzed if a specimen was collected together with the host. My analysis has shown that in Poland *O. caryophyllacea* parasitizes exclusively species of the family Rubiaceae. It infects

G. mollugo in 80% of cases, seldom *G. verum* and very rarely *G. boreale*, e.g. in Sędziejowice or Kików in the Nida Basin. Parasitism on *G. odoratum* was noted only in the “Grabowiec” reserve in the Nida Basin [5] and in Carpathian beech forests in the Pieniny Mts (leg. K. Zarzycki, 26.06.1966, KRAM; see *list of localities*). The species parasitized *Cruciata glabra* only at one locality on the margin of the “Grabowiec” reserve [5] (Fig. 2). Symptoms of host weakening by the parasite were not observed.

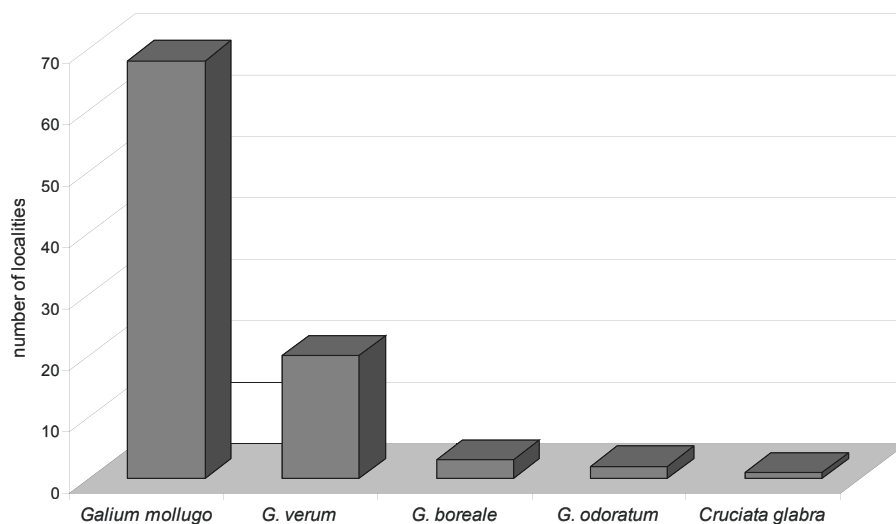


Fig. 2. A comparison of preferred host species of *Orobanche caryophyllacea* in Poland (on the basis of field observations and herbarium research).

Preferred habitats and plant communities

In Poland *Orobanche caryophyllacea* mainly occurs in thermophilous habitats, from the southern sector of the horizon, seldom on west- or north-facing slopes, i.e. xerothermic grasslands of the Festuco-Brometea class, thermophilous meadows Molinio-Arrhenatheretea class. These communities vary considerably depending on the substrate, altitudinal aspect and regional location (Table 1). A description of phytocoenoses preferred by *O. caryophyllacea* in the regions with the highest density of its localities in Poland is given below.

Pieniny Mts. The properties of soils in the Pieniny Mts are different from the soils in the Carpathian Mts which formed from Carpathian flysch [136]. This had a fundamental influence on the distribution of localities of the species belonging to the genus *Orobanche*. *O. caryophyllacea* occurs here on lime soils, shallow or medium deep and highly skeletal rendzinas, less often on brown soils [34]. The species has been reported from thermophilous meadows, especially herbaceous meadows in the Pieniny Mts (Arrhenatheretum elatioris, Gladiolo-Agrostietum capillaris, Anthyllidi-Trifolietum montani associations), at higher altitudes Veratrum lobelianum-Laserpitium latifolium association, xerothermic grassland of the Festuco-Brometea class and alpine grasslands developing on calcareous substrate Seslerietea varia class (ecotones of the thermophilous rock grassland Festucetum pallentis, alpine rock grassland, endemic community Dendranthemum-Seslerietum varia associations, Seslerietea varia class) – community *Calamagrostis varia*: on slopes and screes of S-facing rock gorges, relict pine groves, thermophilous beech groves (Carici albae-Fagetum association), mountain sycamore maple forest Phyllitido-Aceretum association (Tilio platyphyllis-Acerion pseudoplatani alliance) [4,34,114,118,121]. The current field research done by the authors could suggest that at present *O. caryophyllacea* occurs mostly in the Anthyllidi-Trifolietum montani association, thermophilous meadows with xerothermic plants, rarely in communities from Trifolio-Geranietaea sanguinei and Rhamno-Prunetea classes, usually on mild slopes or at flat sites (Table 1).

Nida Basin. *Orobanche caryophyllacea* occurs in xerothermic grasslands, on hills, in pits often remaining after excavation or in quarries still operating in the area, of the Cirsio-Brachypodium pinnati alliance, especially in the Adonido-Brachypodium pinnati, Thalictrum-Salvietum pratensis, rarely Inuletum ensifoliae, and also on gypsum hills in locally differentiated communities Seslerio-Scorzoneretum purpureae and Carex glauca-Tetragonolobus maritimus ssp. siliquosus associations. The only locality in the “Grabowiec” reserve is on gypsum in the oak-hornbeam forest of

the Querco-Fagetea class where it parasitizes *Gallium odoratum*. The species has been rarely recorded in grassland communities of the Sisymbrio-Stipetum capillatae association. These preferred communities are often in mosaic segetal communities of the Stellarietea mediae, shrub communities Rhamno-Prunetea, fringe communities Trifolio-Geranietaea sanguinei and ruderal communities Artemisietea vulgaris classes [5] (Table 1).

Lublin Upland and Roztocze. The species is recorded on sun-exposed hillsides (e.g. Machnowska Mt, Wieprzecka Mt) and in river valleys (Vistula, Wieprz, Huczwa, Kamionka, Łabuńka, Sołokija, Bystrzyca) or on embankments of early medieval earthwork, on calcareous or loess substrate (especially chalky rendzina and rarely chernozems). It prefers open sites where it occurs in xerothermic grasslands of Cirsio-Brachypodium pinnati alliance, especially communities Thalictrum-Salvietum pratensis, Inuletum ensifoliae, Adonido-Brachypodium pinnati associations, with a high contribution of thermophilous fringe species and shrubs of the Trifolio-Geranietaea sanguinei or Rhamno-Prunetea classes [17].

Lower Silesia and Opole region. At present *Orobanche caryophyllacea* occurs in post-excavation serpentinite pits in the Kamienny Grzbiet hill (Nasławice region) in the Ślęza Massif and in the Ogorzelec (Głogów Glacial Valley). A unique community determined as Viscario-Avenuletum pratensis association has formed there. The community comprises species of the Festuco-Brometea, Molinio-Arrhenatheretea, Koelerio glaucae-Coryneporetea canescentis and Trifolio-Geranietaea sanguinei classes [88], (Table 1).

In the Opole province, it occurs at one locality on Góra Gipsowa Mt near Kietrz. The site has persisted since the 19th century. The species grows on former gypsum extraction workings in xerothermic grassland of the Festuco-Brometea class with a high contribution of fringe species of the Geranion sanguinei alliance [104], (Table 1).

Pomerania. On the Lower Oder and Vistula rivers, *Orobanche caryophyllacea* is mostly found on rich moraine calcium carbonate in xerothermic grasslands of the Festuco-Stipion alliance, mainly in Potentillo-Stipetum capillatae associations, often occurring as a mosaic with meadow communities of the Molinio-Arrhenatheretea, fringe communities Trifolio-Geranietaea sanguinei or shrub communities of the Rhamno-Prunetea classes (Table 1).

On Wolin island, the species occurs on strongly disturbed slopes of the Szczecin Lagoon (Lubin area), in thermophilous grassland communities with a high contribution of meadow and ruderal species. It is also encountered on the roadside in a cleared mixed forest towards Wapnica (see *list of localities*, Table 1).

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

| Location | Salkowice | Sędziejowice | Samostrzałów | Kąpy II | Dwikowy | Wawrzyniec Mt | Oweżary | Stary Przylep | Stare Objezierze | Krajnik Dolny | Lubin | Nasawice | Wysokie Skalki | Homole | Okrąglica | Długi Gronik | Kozia Mt | Zankowa Mt | Grabowice | | |
|---|--------------|--------------|--------------|------------|-------------|---------------|--------------|---------------|------------------|---------------|-------------|-------------|----------------|-------------|-------------|--------------|-------------|-------------|------------|-----|---|
| Date | 28.05.2008 | 19.06.2012 | 04.06.2009 | 15.07.2006 | 27.07.2006 | 29.05.2009 | 25.06.2009 | 25.06.2009 | 25.06.2009 | 25.06.2009 | 08.07.2012 | 14.07.2011 | 31.07.2009 | 31.07.2009 | 22.07.2012 | 29.07.2009 | 23.07.2010 | 30.07.2009 | 28.05.2011 | | |
| Latitude [N] | 50°25'05.51" | 50°34'2.8" | 50°35'18.2" | 50°40'22" | 50°44'20" | 53°19'37.5" | 53°11'27.25" | 52°52'53.6" | 53°01'35" | 53°01'35" | 53°51'49" | 50°53'00" | 49°22'49.4" | 49°24'20.1" | 49°24'56.9" | 49°25'08.2" | 49°25'15.6" | 49°25'12.5" | 50°28'21" | C | |
| Longitude [E] | 20°51'24" | 20°39'45" | 20°38'41.6" | 23°07'22" | 21°47'03.9" | 18°22'57.9" | 14°38'43.1" | 14°59'33.5" | 14°21'33.7" | 14°18'37.9" | 14°26'08.2" | 16°49'50.8" | 20°33'20" | 20°32'52.4" | 20°25'20" | 20°26'56.6" | 20°22'09.4" | 20°25'12.9" | 20°34'33" | o | |
| Altitude a.s.l. [m] | 258 | 271 | 244 | 272 | 174 | 92 | 39 | 80 | 65 | 26 | 50 | 174 | 1052 | 568 | 947 | 515 | 791 | 724 | 240 | n | |
| Relative area (m ²) | 25 | 50 | 50 | 50 | 30 | 25 | 50 | 25 | 25 | 25 | 25 | 25 | 15 | 40 | 20 | 25 | 50 | 25 | 50 | s | |
| Exposure | S | SW | SE | SE | S | S | NW | SW | SE | SE | S | SE | S | W | SE | NE | SW | SW | SW | t | |
| Inclination [°] | 10 | 10 | 5 | 10 | 15 | 20 | 10 | 10 | 10 | 15 | 15 | 15 | 60 | 40 | 40 | 15 | 20 | 20 | 5 | a | |
| Cover of tree layer A (%) | - | - | - | - | 10 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 85 | n |
| Cover of shrub layer B (%) | 15 | 15 | - | 15 | 15 | - | - | - | - | 10 | - | - | - | 20 | 15 | 15 | 20 | 35 | 60 | c | |
| Cover of herbaceous layer C (%) | 85 | 85 | 95 | 100 | 100 | 90 | 95 | 95 | 80 | 95 | 100 | 95 | 60 | 95 | 75 | 100 | 100 | 80 | 90 | y | |
| Cover of moss layer D (%) | 5 | 15 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 15 | 20 | 15 | 10 | 5 | 15 | 20 | | |
| Number of species | 57 | 77 | 57 | 34 | 42 | 27 | 31 | 28 | 31 | 35 | 25 | 35 | 22 | 60 | 23 | 45 | 56 | 34 | 33 | | |
| <i>Orobanche caryophyllacea</i> | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | V | |
| Ch. Festuco-Brometea, Festucetalia valesiaca | | | | | | | | | | | | | | | | | | | | | |
| <i>Centaurea scabiosa</i> | + | 1 | + | . | + | + | + | + | + | . | + | + | 1 | . | . | 1 | + | . | . | IV | |
| <i>Euphorbia cyparissias</i> | + | 2 | + | . | + | + | + | . | . | . | . | 1 | . | 1 | . | . | + | + | . | III | |
| <i>Brachypodium pinnatum</i> | 1 | + | + | 2 | 2 | + | 1 | . | + | 3 | . | . | . | . | . | . | . | . | . | III | |
| <i>Centaurea stoebe</i> | . | + | + | . | + | + | + | . | + | + | 3 | + | . | . | . | . | . | . | . | III | |
| <i>Potentilla arenaria</i> | . | 1 | + | . | . | 1 | + | + | + | + | + | + | . | . | . | . | . | . | . | III | |
| <i>Plantago media</i> | + | + | + | . | . | . | . | . | . | + | . | + | . | + | . | + | + | . | . | III | |
| <i>Stipa capillata</i> | . | . | 1 | . | 1 | 4 | 2 | 1 | 1 | + | . | . | . | . | . | . | . | . | . | II | |
| <i>Artemisia campestris</i> | + | + | + | + | + | . | . | . | + | + | . | . | . | . | . | . | . | . | . | II | |
| <i>Phleum phleoides</i> | . | + | . | . | + | + | + | . | 4 | + | . | . | . | . | . | . | . | . | . | II | |
| <i>Veronica spicata</i> | . | + | + | . | . | . | + | + | . | + | . | 1 | . | . | . | . | . | . | . | II | |

| Location | Salkowice | Sędziejowice | Samo-strzałów | Kąty II | Dwikozły | Wawrzyniec Mt | Owczary | Stary Przylep | Stare Obyzierz | Krajnik Dolny | Lubin | Nasławice | Wysokie Skłaki | Homole | Okrąglica | Długi Gronik | Kozia Mt | Zamkowa Mt | Grabowice | |
|--------------------------------|-----------|--------------|---------------|---------|----------|---------------|---------|---------------|----------------|---------------|-------|-----------|----------------|--------|-----------|--------------|----------|------------|-----------|----|
| <i>Salvia verticillata</i> | . | . | + | + | I | + | . | . | . | . | . | . | . | + | . | . | + | . | . | II |
| <i>Achillea pannonica</i> | . | + | . | . | . | + | + | + | . | . | . | + | . | . | . | . | . | . | . | II |
| <i>Dianthus carthusianorum</i> | . | + | . | . | . | + | + | . | + | . | . | + | . | . | . | . | . | . | . | II |
| <i>Carex flacca</i> | I | . | + | 3 | . | . | . | . | . | . | . | . | . | + | . | + | . | . | . | II |
| <i>Melampyrum arvense</i> | + | + | + | + | . | . | . | . | + | . | . | . | . | . | . | . | . | . | . | II |
| <i>Koeleria macrantha</i> | . | + | . | . | . | . | + | . | + | . | . | + | . | . | . | . | . | . | . | II |
| <i>Scabiosa ochroleuca</i> | . | + | . | + | . | . | . | . | . | . | . | + | . | . | + | . | . | . | . | II |
| <i>Festuca rupicola</i> | I | I | + | . | I | . | . | . | . | . | . | . | . | . | . | . | . | . | . | II |
| <i>Filipendula vulgaris</i> | . | . | + | . | + | . | . | . | . | + | . | + | . | . | . | . | . | . | . | II |
| <i>Acinos arvensis</i> | + | + | + | . | . | . | . | . | . | . | . | . | . | + | . | . | . | . | . | II |
| <i>Adonis vernalis</i> | + | I | . | . | I | . | . | . | . | . | . | . | . | . | . | . | . | . | . | I |
| <i>Asperula tinctoria</i> | + | + | . | . | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | I |
| <i>Campanula sibirica</i> | + | + | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | I |
| <i>Festuca pallens</i> | . | . | . | . | . | . | . | . | . | . | . | . | 2 | + | 2 | . | . | . | . | I |
| <i>Onobrychis viciifolia</i> | + | . | + | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | I |
| <i>Sesleria uliginosa</i> | + | 2 | I | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | I |
| <i>Allium montanum</i> | . | . | . | . | . | . | . | . | . | . | . | . | I | . | I | . | . | . | . | I |
| <i>Allium oleraceum</i> | . | . | . | . | . | . | . | . | + | + | . | . | . | . | . | . | . | . | . | I |
| <i>Asperula cynanchica</i> | . | + | . | . | . | . | + | . | . | . | . | . | . | . | . | . | . | . | . | I |
| <i>Avenula pratensis</i> | . | . | . | . | . | . | . | . | . | 4 | . | 3 | . | . | . | . | . | . | . | I |
| <i>Campanula glomerata</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | + | . | . | I |
| <i>Carex humilis</i> | + | 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | I |
| <i>Carlina vulgaris</i> | + | . | . | . | . | . | . | . | . | . | . | + | . | . | . | . | . | . | . | I |
| <i>Scorzonera purpurea</i> | . | 2 | . | . | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | I |
| <i>Stachys recta</i> | . | + | . | . | . | . | . | . | . | + | . | . | . | . | . | . | . | . | . | I |
| <i>Stipa joannis</i> | . | I | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | I |

| Location | Sulkowice | Śpółziejowice | Samostrzałów | Kąty II | Dwikopy | Wawrzyniec Mt | Owczary | Stary Przylep | Stare Objezierze | Krapnik Dolny | Lubin | Nasławice | Wysokie Skalki | Homole | Okrąglica | Długi Gronik | Kozia Mt | Zankowa Mt | Grabowice | |
|--|-----------|---------------|--------------|---------|---------|---------------|---------|---------------|------------------|---------------|-------|-----------|----------------|--------|-----------|--------------|----------|------------|-----------|-----|
| <i>Tetragonolobus maritimus</i> subsp. <i>siliquosus</i> | + | . | 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 |
| <i>Thesium linophyllum</i> | + | 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 |
| <i>Thymus pannonicus</i> | + | 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 |
| <i>Inula ensifolia</i> | 2 | . | . | 2 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 |
| <i>Sisymbrium polymorphum</i> | + | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 |
| <i>Seseli annuum</i> | . | + | . | . | . | . | . | . | . | . | . | + | . | . | . | . | . | . | . | 1 |
| Ch. Trifollio-Geranieta sanguinei | | | | | | | | | | | | | | | | | | | | |
| <i>Galium verum</i> | + | 1 | + | . | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 2 | . | . | . | + | . | . | . | IV |
| <i>Medicago falcata</i> | 1 | 1 | + | 1 | 2 | . | + | + | + | 1 | . | . | . | + | . | . | + | . | . | III |
| <i>Coronilla varia</i> | . | + | + | + | + | . | . | . | + | . | . | + | . | . | . | . | + | + | . | III |
| <i>Agrimonia eupatoria</i> | . | . | + | + | . | . | . | . | . | . | . | + | . | . | . | . | + | . | . | II |
| <i>Origanum vulgare</i> | . | . | + | 1 | + | . | . | . | . | . | . | . | . | . | . | . | 1 | . | . | II |
| <i>Trifolium montanum</i> | . | 1 | . | . | + | . | . | . | . | + | . | . | . | + | . | . | + | . | . | II |
| <i>Thalictrum minus</i> | + | . | + | . | . | + | . | 3 | . | + | . | . | . | . | . | . | . | . | . | II |
| <i>Clinopodium vulgare</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | + | + | . | 1 | . | . | II |
| <i>Fragaria viridis</i> | . | + | + | . | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | II |
| <i>Peucedanum cervaria</i> | + | . | . | + | . | . | . | . | . | + | . | . | . | . | . | . | . | . | . | 1 |
| <i>Peucedanum oreoselinum</i> | . | 2 | . | . | + | . | 1 | . | . | . | . | . | . | . | . | . | . | . | . | 1 |
| <i>Viola hirta</i> | + | + | . | . | . | . | . | . | . | . | . | . | . | + | . | . | . | . | . | 1 |
| <i>Bupleurum falcatum</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | + | + | . | . | . | . | 1 |
| <i>Arenaria sylvestris</i> | . | + | . | 2 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 |
| <i>Campanula rapunculoides</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | . | . | + | . | 1 |
| <i>Veronica teucrium</i> | . | + | . | . | . | . | . | . | . | + | . | . | . | . | . | . | . | . | . | 1 |
| <i>Vicia tenuifolia</i> | . | + | . | . | . | . | . | . | . | . | . | . | . | + | . | . | . | . | . | 1 |
| <i>Valeriana angustifolia</i> | + | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 |

| Location | Sulkowice | Sędziejowice | Samoszałów | Kąty II | Dwilkozy | Wawrzyniec Mt | Owczary | Stary Przylep | Stare Objezierze | Krajnik Dolny | Lubin | Naslawice | Wysokie Skalki | Homole | Okraglica | Długi Gronik | Kozia Mt | Zamkowa Mt | Grahowice | |
|------------------------------------|-----------|--------------|------------|---------|----------|---------------|---------|---------------|------------------|---------------|-------|-----------|----------------|--------|-----------|--------------|----------|------------|-----------|-----|
| Ch. Molinio-Arrhenatheretea | | | | | | | | | | | | | | | | | | | | |
| <i>Galium mollugo</i> | 4 | 2 | 3 | 1 | 2 | 2 | . | . | 1 | + | 1 | 1 | + | 2 | 3 | 3 | 3 | + | . | V |
| <i>Dactylis glomerata</i> | + | + | + | + | + | + | + | + | + | + | 3 | . | . | . | . | + | 1 | + | . | IV |
| <i>Achillea millefolium</i> | + | + | + | . | . | . | + | + | . | . | 1 | + | 1 | . | . | . | + | . | . | III |
| <i>Arrhenatherum elatius</i> | + | + | + | 2 | . | + | 1 | 1 | . | . | . | . | . | . | . | 2 | 3 | . | . | III |
| <i>Festuca rubra</i> | 1 | 1 | + | . | . | . | . | . | . | . | 3 | . | . | . | . | 2 | 2 | . | . | II |
| <i>Koeleria arvensis</i> | . | + | . | . | . | . | + | . | . | . | . | . | . | + | . | + | + | . | . | II |
| <i>Leucanthemum vulgare</i> | + | . | + | 2 | . | . | . | . | . | . | . | . | . | . | . | + | + | . | . | II |
| <i>Plantago lanceolata</i> | . | + | + | . | . | . | . | . | . | . | 2 | + | . | . | . | 1 | . | . | . | II |
| <i>Anthyllis vulneraria</i> | . | + | . | . | . | . | . | . | . | . | . | . | . | 1 | . | + | . | . | . | I |
| <i>Campanula patula</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | + | + | . | . | I |
| <i>Centaurea jacea</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | + | + | . | . | I |
| <i>Galium boreale</i> | + | 2 | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | I |
| <i>Leontodon hispidus</i> | + | . | + | . | . | . | . | . | . | . | . | . | . | + | . | . | . | . | . | I |
| <i>Taraxacum officinale</i> agg. | . | . | . | . | + | . | . | . | . | . | . | . | + | . | . | . | . | + | . | I |
| <i>Trifolium pratense</i> | . | + | . | . | . | . | . | . | . | . | . | . | . | + | . | + | . | . | . | I |
| <i>Trifolium repens</i> | . | . | . | . | . | . | . | . | . | . | + | . | . | + | . | . | + | . | . | I |
| <i>Vicia cracca</i> | . | + | . | . | + | . | . | . | . | . | . | . | . | . | . | + | . | . | . | I |
| <i>Rumex thyrsiflora</i> | . | + | + | . | . | . | . | . | . | . | + | . | . | . | . | . | . | . | . | I |
| <i>Festuca pratensis</i> | . | . | + | . | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | I |
| <i>Lathyrus pratensis</i> | . | . | + | . | . | . | . | . | . | . | . | . | . | . | . | + | . | . | . | I |
| <i>Phleum pratense</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | + | . | I |
| <i>Prunella vulgaris</i> | . | . | + | . | . | . | . | . | . | . | . | . | . | . | . | + | . | . | . | I |
| <i>Tragopogon pratensis</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | + | . | . | I |
| Ch. Artemisiaetea vulgaris | | | | | | | | | | | | | | | | | | | | |
| <i>Echium vulgare</i> | . | . | + | . | . | . | . | 3 | + | . | . | . | + | . | . | . | . | . | . | II |
| <i>Anchusa officinalis</i> | . | . | . | . | . | + | . | + | . | . | + | . | . | . | . | . | . | . | . | I |
| <i>Artemisia vulgaris</i> | . | + | . | . | . | . | . | . | . | . | + | . | . | . | . | . | . | . | . | I |

| Location | Sulkowice | Sędziejowice | Samostrzałów | Kąty II | Dwikowy | Wawrzyniec Mt | Owczary | Stary Przylep | Stare Objezierze | Krajnik Dolny | Lubin | Naslawice | Wysokie Skalki | Homole | Okraglica | Długi Gronik | Kozia Mt | Zamkowa Mt | Grabowice | |
|--|-----------|--------------|--------------|---------|---------|---------------|---------|---------------|------------------|---------------|-------|-----------|----------------|--------|-----------|--------------|----------|------------|-----------|---|
| <i>Descurainia sophia</i> | . | . | . | . | . | + | . | + | . | . | . | . | . | . | . | . | . | . | . | . |
| <i>Geranium robertianum</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | . | . | . | . | + |
| <i>Geum urbanum</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | . | . | . | . | + |
| Ch. Rhamno-Prunetea | | | | | | | | | | | | | | | | | | | | |
| <i>Prunus spinosa C</i> | . | . | + | . | . | . | . | . | + | + | I | . | . | . | . | + | + | . | . | + |
| <i>Cotoneaster integerrimus B</i> | . | . | . | . | . | . | . | . | . | . | . | . | + | + | . | . | . | . | I | . |
| <i>Crataegus monogyna B</i> | . | . | . | . | . | . | . | . | . | I | . | . | . | . | . | + | . | . | . | + |
| <i>Prunus spinosa B</i> | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | 2 | . | . | . |
| <i>Crataegus monogyna C</i> | . | . | . | . | . | . | + | . | . | . | . | . | . | . | . | . | . | . | . | + |
| <i>Rosa dumalis B</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | I | 2 | . | . |
| Ch. Quercu-Fagetea | | | | | | | | | | | | | | | | | | | | |
| <i>Acer pseudoplatanus C</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | + | . | . | . | . |
| <i>Corylus avellana C</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | . | . | + | . |
| <i>Corylus avellana B</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 2 | 3 |
| <i>Epipactis helleborine</i> | . | . | . | . | . | . | . | . | . | . | . | . | + | + | . | . | . | . | . | . |
| <i>Lonicera xylosteum C</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | + | . | . |
| <i>Melica nutans</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 2 | . | . | . | . | I |
| <i>Pulmonaria obscura</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + |
| Ch. Epilobietea angustifolii | | | | | | | | | | | | | | | | | | | | |
| <i>Fragaria vesca</i> | . | . | + | . | . | . | . | . | . | . | . | . | + | 2 | + | . | + | . | . | + |
| <i>Calamagrostis epigejos</i> | . | . | . | . | . | . | . | + | . | . | I | + | . | I | . | . | . | . | . | + |
| <i>Rubus idaeus</i> | . | . | . | . | . | . | . | . | . | . | . | . | + | . | + | . | + | . | . | . |
| <i>Verbascum nigrum</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Ch. Agropyretea intermedio-repentis | | | | | | | | | | | | | | | | | | | | |
| <i>Convolvulus arvensis</i> | . | . | + | . | . | . | . | . | . | + | + | . | . | . | . | . | . | . | . | . |
| <i>Falcaria vulgaris</i> | . | . | . | . | . | . | . | . | . | + | . | . | . | . | . | . | . | . | . | . |

| Location | Sulkowice | Sędziejowice | Samo- strzałów | Kąty II | Dwikozy | Wawrzyniec Mt | Owczary | Stary Przylep | Stare Ojcieczerze | Krajnik Dolny | Lubin | Nasławice | Wysokie Skałki | Homole | Okrąglica | Długi Gronik | Kozia Mt | Zamkowa Mt | Grabowice | |
|--|-----------|--------------|-------------------|---------|---------|------------------|---------|---------------|----------------------|------------------|-------|-----------|-------------------|--------|-----------|-----------------|----------|---------------|-----------|-----|
| Ch. Sesslerieta variae | | | | | | | | | | | | | | | | | | | | |
| <i>Sessleria varia</i> | . | . | . | . | . | . | . | . | . | . | . | . | + | 3 | 4 | . | . | . | . | I |
| <i>Saxifraga paniculata</i> | . | . | . | . | . | . | . | . | . | . | . | . | + | + | . | . | . | . | . | I |
| Ch. Nardo-Callunetea | | | | | | | | | | | | | | | | | | | | |
| <i>Polygala vulgaris</i> | + | + | . | + | . | . | . | . | . | + | . | . | . | . | . | . | . | . | . | II |
| <i>Cuscuta epithymum</i> | . | + | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | . | . | I |
| <i>Potentilla erecta</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | . | I |
| Ch. Koelerio glaucae-Corynephorotea canescentis | | | | | | | | | | | | | | | | | | | | |
| <i>Sedum acre</i> | . | . | . | . | . | . | + | . | + | . | . | . | + | . | . | . | . | . | . | I |
| <i>Trifolium arvense</i> | . | . | . | . | . | . | . | . | + | . | . | 2 | . | . | . | . | . | . | . | I |
| Others | | | | | | | | | | | | | | | | | | | | |
| <i>Thymus pulegioides</i> | + | + | . | . | . | . | + | . | + | + | . | I | + | + | . | + | + | . | . | III |
| <i>Vincetoxicum hirundinaria</i> | + | + | . | . | . | . | + | . | . | + | . | . | + | + | + | . | . | . | + | III |
| <i>Pimpinella saxifraga</i> | . | . | . | . | . | . | . | . | . | . | . | + | . | + | + | 2 | + | + | . | III |
| <i>Salvia pratensis</i> | + | + | I | . | . | . | + | . | + | . | . | . | . | . | . | . | . | . | . | II |
| <i>Orobancha lutea</i> | + | + | + | + | + | . | + | . | . | + | . | . | . | . | . | . | + | + | . | II |
| <i>Briza media</i> | + | . | . | . | . | . | . | . | . | + | . | . | . | . | . | . | + | + | . | II |
| <i>Hypericum perforatum</i> | . | . | . | . | . | . | . | . | . | . | + | + | . | . | . | . | + | + | . | II |
| <i>Ranunculus acer</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | . | + | . | . | II |
| <i>Festuca trachyphylla</i> | + | I | . | + | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | II |
| <i>Primula veris</i> | + | . | + | . | . | . | . | + | . | . | . | . | . | . | . | . | + | . | . | II |
| <i>Sanguisorba minor</i> | + | + | + | . | . | . | . | . | . | . | . | . | + | . | . | . | . | . | . | II |
| <i>Agrostis capillaris</i> | . | . | . | . | . | . | . | . | . | . | + | . | . | . | . | . | 1 | . | . | I |
| <i>Digitalis grandiflora</i> | . | . | . | . | . | . | . | . | . | . | . | . | + | . | 2 | . | + | . | . | I |
| <i>Laserpitium latifolium</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | 2 | 2 | . | I |
| <i>Medicago lupulina</i> | . | . | . | . | . | . | . | . | + | . | . | . | + | + | . | . | . | . | . | I |
| <i>Sedum maximum</i> | . | + | . | . | . | . | . | . | . | . | . | . | . | + | . | . | . | + | . | I |

| Location | Sulkowice | Sędziejowice | Samostraków | Kąpy II | Dwikopy | Wawrzyniec Mt | Owczary | Stary Przylep | Stare Objezierze | Krajnik Dolny | Lubin | Naslawice | Wysokie Skalki | Homole | Okrąglica | Długi Gronik | Kozia Mt | Zamkowa Mt | Grabowice |
|-------------------------------|-----------|--------------|-------------|---------|---------|---------------|---------|---------------|------------------|---------------|-------|-----------|----------------|--------|-----------|--------------|----------|------------|-----------|
| <i>Veronica chamaedrys</i> | . | + | + | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | . |
| <i>Abyssum abyssoides</i> | . | . | . | . | . | . | + | . | . | + | . | . | . | . | . | . | . | . | . |
| <i>Anithoxanthum odoratum</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | . | . |
| <i>Arenaria serpyllifolia</i> | . | . | . | . | . | . | . | + | . | . | . | . | + | . | . | . | . | . | . |
| <i>Camelina microcarpa</i> | . | . | . | . | . | . | . | + | . | . | . | . | . | . | . | . | . | . | . |
| <i>Carex hirta</i> | . | . | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| <i>Carlina acutis</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | . | + | . | . |
| <i>Festuca</i> sp. | . | . | . | . | . | 3 | . | . | 1 | . | . | . | . | . | . | . | . | . | . |
| <i>Hieracium sphondylium</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| <i>Linum catharticum</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | . |
| <i>Orchis militaris</i> | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| <i>Quercus robur</i> C | . | . | . | . | . | . | . | . | . | . | + | . | . | . | . | . | . | . | . |
| <i>Rosa</i> sp. B | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| <i>Rosa</i> sp. C | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| <i>Rubus caesius</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| <i>Senecio vulgaris</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| <i>Solidago virgaurea</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| <i>Polypodium vulgare</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 2 |
| <i>Turritis glabra</i> | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |

Sporadic: *Ch. Festuco-Brometea, Festucetalia valesiacae:* *Achillea collina* 9, *A. setacea* 5, *Ajuga genevensis* 12, *Alyssum montianum* 2, *Anthriscum liliago* 9(1), *Arabis hirsuta* 14, *Asparagus officinalis* 6(1), *Carex praecox* 6, *Eryngium campestre* 1, *Gentiana cruciata* 14, *Helianthemum mummularium* 1, *Hieracium batianii* 4, *Linum flavum* 4, *Oxytropis pilosa* 10, *Scabiosa caespitosa* 2, *S. columbata* 8, *Teucrium chamaedrys* 4; **Ch. Trifolio-Geranietea sanguinei:** *Anthriscum ranosum* 10(1), *Geranium sanguineum* 2, *Inula hirta* 5, *Lathyrus sylvestris* 16, *Libanotis pyrenaica* 15, *Polygonatum odoratum* 19(1), *Trifolium alpestre* 12, *T. medium* 17(2), *Verbascum lychitis* 2; **Ch. Quercu-Fagea:** *Acer pseudoplatanus* B 16, *A. platanoides* A 5(1), *Actaea spicata* 19, *Aegopodium podagraria* 19, *Asarum europaeum* 14, *Astrantia major* 18, *Carpinus betulus* A 19(2), *Clematis alpina* B 19, *Cerasus avium* B 19, *Cruciatia glabra* 19(1), *Eucnymus verrucosa* B 19, *Fagus sylvatica* A 18(2), C 18, *Fraxinus excelsior* B 1, C 14, *Galium odoratum* 19(4), *Geranium phaeum* 17, *Lilium martagon* 19, *Lonicera xylosteum* B 15, *Melittis melisophyllum* 19, *Milium effusum* 19, *Phyteuma spicatum* 18, *Poa nemoralis* 19, *Salvia glutinosa* 18, *Santcula europaea* 19, *Sorbus aria* C 18, *Stachys sylvatica* 19, *Stellaria holostea* 19, *S. nemorum* 19, *Tilia cordata* B 5(1); **Ch. Molinio-Arrhenatheretea:** *Angelica sylvestris* 16, *Bellis perennis* 14, *Deschampsia caespitosa* 17, *Gentiana pneumonanthe* 16, *Gladiolus imbricatus* 16, *Leontodon autumnalis* 17, *Lotus corniculatus* 12, *Rhinanthus minor* 12; **Ch. Artemisietea vulgaris:** *Artemisia absinthium* 11(2), *Berteroa incana* 9, *Carduus crispus* 6, *C. nutans* 8(2), *Chaerophyllum aromaticum* 17, *Conyza canadensis* 8, *Cynoglossum officinale* 8, *Galium aparine* 1, *Melandrium album* 8, *Melilotus albus* 11, *Solidago gigantea* 5, *Tanacetum vulgare* 12, *Urtica dioica* 11; **Ch. Vaccinio-Piceetea:** *Abies alba* B 18, *Pinus sylvestris* A 4, B 4(1), C 9, *Picea abies* A 17(2), B 14(1), C 14; **Ch. Rhamno-Prunetea:** *Cerasus fruticosa* B 5, *Cornus sanguinea* B 1, C 14, *Rhamnus cathartica* B 2(1), *Viburnum opulus* C 14; **Ch. Epilobietea angustifolii:** *Sambucus nigra* B 19(3), C 19; **Ch. Agropyreteae intermedio-repentis:** *Elymus hispidus* 2, *E. repens* 17, *Rumex crispus* 11; **Ch. Betulo-Adenostyletea:** *Bupleurum longifolium* 17, *Calamagrostis villosa* 18(1), *Senecio nemorosus* 18, **Ch. Seslerietea varia:** *Carduus glaucus* 15, *Phyteuma orbiculare* 14, *Scabiosa lucida* 15; **Ch. Nardo-Callunetea:** *Hieracium pilosella* 14(1), *H. umbellatum* 13; **Ch. Koelerio glaucae-Corynephoretea canescens:** *Helictrysum arenarium* 9, *Senecio vernalis* 6, *Silene otites* 9, *Trifolium campestre* 12; **Ch. Stellarietea mediae:** *Lathyrus tuberosus* 2, *Papaver rhoeas* 10, *Potentilla argentea* 11, *Vicia hirsuta* 7, *Viola arvensis* 8; **Others:** *Aesculus hippocastanum* B 1, *Alchemilla* sp. 17, *Betula pendula* A 5, B 5, C 5, *Calamagrostis varia* 15(2), *Carex spicata* 18, *Euphrasia* sp. 14, *Festuca ovina* s.l. 12(2), *Frangula alnus* B 19, *Gymnadenia conopsea* 4, *Hieracium mucronatum* 18, *Jovibarba sobolifera* 14, *Juniperus communis* B 14(1), C 14, *Lappula squarrosa* 8, *Lavatera thuringiaca* 6, *Listera ovata* 14, *Lithospermum officinale* 5, *Melanampyrum nemorosum* 19, *Melandrium rubrum* 18, *Mycelis muralis* 18, *Ononis arvensis* 17, *O. spinosa* 7, *Orchis italata* 1, *Orobanchae alba* subsp. *major* 4, *O. kochii* 2, *O. mayeri* 15; *Peucedanum alsaticum* 4, *Potentilla heptaphylla* 12, *Pulsatilla pratensis* 2, *Pyris communis* A 5, B 1, P, *pp-raster* B, C 11, *Quercus robur* A 19(4), *Ranunculus bulbosus* 1, *Reseda phyteuma* 2, *Rhinanthus glaber* 14, *Senecio jacobaea* 16, *Sorbus* sp. A 18(1), B 18, C 14, *Stellaria graminea* 17, *Verbascum thapsus* 11, *Viola mirabilis* 19, *Viscaria vulgaris* 12(1).

DISCUSSION

In Poland *Orobanche caryophyllacea* mainly occurs in the Małopolska Upland (chiefly the Nida Basin and Middle Vistula River Valley), Lublin Upland, Roztocze, Przemyśl Foothills, Sudeten Foreland, Silesian Basin, Pieniny Mts and Pomerania: Lower Vistula and Oder rivers, Wolin island. A total of 160 localities of *O. caryophyllacea* are known in Poland, of which ca. 120 have been confirmed and documented by herbarium specimens or photographs. Approximately 60 sites have been confirmed after 2000. Many sites were noted in the 19th century and are now historical. *O. caryophyllacea* is one of the most sensitive species to changes in the phytoconoesis structure among species of the genus *Orobanche* found in Poland. The verification showed that the species had been incorrectly reported, for instance, from the Śląsko-Krakowska Upland, Małopolska Upland and adjacent areas. It was usually confused with *O. lutea* and *O. kochii*, which are frequent there. A verified and updated distribution map (Fig. 1) of the ATPOL map [137,138] shows considerable differences and it is a result of errors and difficulties in determining the genus *Orobanche*.

The herbarium revision and field investigations also showed that *Orobanche teucarii* reported from Poland in the Polish part of the Pieniny Mts [34, after Jasiewicz] or in the Lublin region [35] was reported incorrectly and the species was in fact *O. caryophyllacea*.

Orobanche caryophyllacea prefers xerothermic grasslands of the Festuco-Brometea class, fringe communities of the Trifolio-Geranietea sanguinei class, thermophilous meadows (Arrhenatherion elatioris alliance) of the Molinio-Arrhenatheretea class, rarely alpine grasslands Seslerietea varia class developing on calcareous substrate, cleared oak-hornbeam forests of the Querco-Fagetea class, such as sycamore maple in the Pieniny Mts, “Grabowiec” reserve in the Nida Basin. It colonizes soils such as shallow rendzinas, loess and chernozems. The species is recorded in lowland areas, from 29 m in Pomerania and Wielkopolska, 140–270 m in the belt of the Polish Uplands to 1050 m a.s.l. in the Pieniny Mts (Wysokie Skałki).

Orobanche caryophyllacea is oligophagous and parasitizes species of the family Rubiaceae, genus *Galium*: *G. mollugo*, *G. verum*, rarely *G. boreale*, sporadically *G. odoratum* and *Cruciata glabra*. *O. lutea* and *O. caryophyllacea* are some of the earliest flowering species of the genus *Orobanche* in Poland. The flowering peak is observed in late May and early June. *O. caryophyllacea* is characterized by the fact that it emits a strong scent resembling the smell of cloves. Representatives of the genus *Bombus* (Apidae) were the most frequently observed pollinating insects, al-

though the genus *Myrmica* (Formicidae) and other genera were also noted (Piwowarczyk unpublished).

The abundance of *Orobanche caryophyllacea* populations varies regionally in Poland and fluctuates considerably annually. Its populations are usually not very abundant and mostly comprise 5 to 20 specimens. The most abundant populations are recorded in Lower Silesia (Kamienny Grzbiet) – over 300 specimens [88], in the Nida Basin, e.g. Kików and Chomentówek – 200 specimens at each, Gartatowice, Samostrzałów, Grabowiec, Górki – 100 specimens each [5]. The populations in the Lublin Upland are also quite abundant and 50 specimens were recorded in Kały, Dobużek or Przeorsk [17].

Orobanche caryophyllacea is strictly protected in Poland (Regulation 2012). It is also included in the regional red lists and books: in Gdańsk Pomerania, CR [139]; Western Pomerania and Wielkopolska, E [140]; Sudeten Mts, EN [141]; Opole province, CR [104], Lower Silesia province, endangered, EN [142], Kujawy-Pomerania region, R (rare) [143], Południowopodlaska Lowland, DD [144], Proszowicki Plateau, EN [145], Małopolska Upland, VU [146]. The species is also vulnerable in neighbouring countries, i.e. Germany [147,148] and the Czech Republic [149].

The progressing process of secondary succession of tree and shrub vegetation, the density of the herb layer and the cessation of former management methods are the main threats to *Orobanche caryophyllacea*. The localities are also often situated near arable fields where they are exposed to chemical agents. The influence of invasive species also poses a considerable threat. *Heracleum sosnowskyi* has been moving worryingly close to the *O. caryophyllacea* population (Gipsowa Góra). Mass self-sowing of *Solidago gigantea* and *Calamagrostis epigejos* are observed at many sites. Many localities are at disturbed sites or at operating excavation sites (limestone, serpentinite). Only a minority of localities are protected: within national parks – Wolin and Pieniny National Parks; reserves – e.g. Brodogóry, Stary Przylep, Bielek, Zbocza Płutowskie, Góra Św. Wawrzyńca, Gipsowa Góra, Stawska Góra, Machnowska Góra, Skarpa Dobużańska, Homole, Grabowiec, Zimne Wody; as ecological sites, e.g. Dwikozy, Owczary, or within Natura 2000 sites. This does not ensure the preservation of the species as active protection, which is not always introduced, is needed. At least some of the localities should be protected as ecological sites and active protection measures should be implemented: mowing or grazing of excessively developing field and herbaceous vegetation, while preserving the unique mosaic systems of grasslands and fringe communities, and nature monitoring. The abundance of the host species of the genus *Galium* should also be monitored.

Species biodiversity at the localities occupied by *Orobanche caryophyllacea* is also high. Many species extremely rare in Poland were observed when phytosociological relevés were performed in the communities with *O. caryophyllacea*. These include: *Achillea setacea*, *Adonis vernalis*, *Anthericum liliago*, *Cerasus fruticosa*, *Linum flavum*, *Orchis ustulata*, *Orobanche alba* subsp. *major*, *O. elatior*, *O. mayeri*, *Oxytropis pilosa*, *Phyteuma orbiculare*, *Peucedanum alsaticum*, *Reseda phyteuma*, *Scorzonera purpurea*, *Sesleria varia*, *Stipa joannis*, and other (Tab. 1).

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***Orobanche caryophyllacea* (Orobanchaceae) w Polsce: rozmieszczenie, taksonomia, fitocenozy i żywiciele**

Streszczenie

Zaraza przytuliowa *Orobanche caryophyllacea* Sm. (Orobanchaceae) należy do gatunków europejsko-zachodnioazjatyckich. Występuje w Europie od Francji, poprzez południową Anglię, Holandię, Niemcy, Polskę, Estonię, region śródziemnomorski do Azji Mniejszej, Kaukazu i Iranu. *O. caryophyllacea* występuje w Polsce głównie na Wyżynie Małopolskiej (zwłaszcza Niecka Nidziańska, Małopolski Przełom Wisły), Wyżynie Lubelskiej, Rostoczu, rzadko na Pogórzu Przemyskim, Przedgórzu Sudeckim i w Kotlinie Śląskiej, na Pomorzu: Dolna Wisła i Odra, Wyspie Wolin oraz w Pieninach. Liczba stanowisk *O. caryophyllacea* w Polsce wynosi ponad 160, z czego ok. 120 zostało udokumentowanych okazami zielnikowymi lub fotografią. Ok. 60 stanowisk zostało potwierdzonych po 2000 roku. Wiele ze stanowisk to notowania XIX wieczne i należą już do historycznych. Weryfikacja wykazała, że gatunek ten został pomyłkowo podawany m.in. z Wyżyny Śląsko-Krakowskiej, z wielu stanowisk na Wyżynie Małopolskiej. Mylony był najczęściej z często tam występującymi *O. lutea* i *O. kochii*. Rewizja zielnikowa i badania terenowe wykluczyły również błędnie podany z Polski gatunek *O. teucriti*, m.in. z Pienin, czy z Lubelszczyzny. Notowania te dotyczyły *O. caryophyllacea*. Zaraza przytulinowa należy do oligofagów i pasożytuje w Polsce na gatunkach z rodziny Rubiaceae, z rodzaju *Galium*: *G. mollugo*, *G. verum*, rzadko *G. boreale*, sporadycznie *G. odoratum* oraz *Cruciata glabra*. Preferuje murawy kserotermiczne z klasy Festuco-Brometea, zbiorowiska okrajkowe z klasy Trifolio-Geranietae sanguinei, ciepłolubne łąki (*Arrhenatherion elatioris*) z klasy Molinio-Arrhenatheretea, rzadko wysokogórskie murawy

rozwijające się na podłożu wapiennym *Seslerietea varia*, prześwietlone zbiorowiska grądowe (np. jaworzyny w Pieninach, grąd na gipsie w rezerwacie Grabowiec w Niece Nidziańskiej) z klasy *Querco-Fagetea*. Gatunek notowany jest na terenach nizinnych, od 29 m na Pomorzu i Wielkopolsce, poprzez 140–270 m w pasie Wyżyn Polskich, do 1050 m n.p.m. w Pieni-

nach (Wysokie Skałki). Należy do gatunków ściśle chronionych w Polsce. Znajduje się również na regionalnych czerwonych listach i w księgach. Zagrożeniem dla gatunku jest przede wszystkim postępujący proces sukcesji wtórnej roślinności drzewiastej i krzewiastej, a także zwarcie warstwy zielonej, oraz zaniechanie dawnych metod użytkowania.

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