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A REVISION OF DISTRIBUTION AND HISTORICAL ANALYSIS OF PREFERRED HOSTS OF *Orobanche ramosa* (Orobanchaceae) IN POLAND

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Abstract

The Polish localities of *Orobanche ramosa* L., branched broomrape, are either extinct or have not been confirmed for many years. This paper presents two new localities of *O. ramosa* in Poland from the Płaskowyż Proszowicki plateau (Wyżyna Małopolska upland) and the Nizina Nadwiślańska lowland (Kotlina Sandomierska basin). Habitat preferences and the abundance at the sites are described. A revised map of the distribution and a historical analysis of preferred hosts in Poland are included. The taxonomy, biology, ecology and control methods of *O. ramosa* are also discussed.

Key words: *Orobanche ramosa*, distribution, taxonomy, archaeophyte, host, Poland

INTRODUCTION

Orobanche ramosa L., branched broomrape, belongs to the parasitic family Orobanchaceae. Of approximately 200 species of the genus *Orobanche* (Pusch and Günther, 2009), six parasitize crop plants: *O. aegyptiaca, O. cernua, O. crenata, O. cumana*, *O. minor* and *O. ramosa* (Sauerborn, 1991; Parker, 1994). *O. ramosa*, *O. crenata* and *O. cumana* are the prominent species that increasingly cause agricultural problems in Southern and South-Eastern European countries. *O. ramosa* has long been known in Central Europe as a parasite of hemp and tobacco but it did not have a major agricultural impact; it has recently become an aggressive weed that adapts to new hosts and causes considerable crop losses (Wegmann, 2004).

Orobanche ramosa is a widespread species. Its range extends in Europe and Western Asia (Jäger and Werner, 2002). It occurs in Central (northwards to England, the Netherlands, northern Germany, Poland, Estonia and the former USSR) and Southern Europe, in Asia, northern and southern Africa, north America and southern Australia. The species probably travelled to Central Europe from Asia with hemp crops ca. 500 BC (Kreutz, 1995; Pusch and Günther, 2009).

The Polish localities of *Orobanche ramosa* are rare and mostly extinct or have not been confirmed for many years. *O. ramosa* is red-listed in Poland as a rare, potentially threatened species (R) (Zarzycki and Szeląg, 2006). It is classified as a species of indeterminate status (I) in the Kujawy-Pomeranian region (Rutkowski, 1997), as extinct (Ex) in Western Pomerania and Wielkopolska (Żukowski and Jackowiak, 1995), regionally extinct (RE) in Gdańsk Pomerania (Markowski and Buliński, 2004; Olszewski and Markowski, 2006), and extinct (Ex) in the Kraków Voivodeship (Zając and Zając, 1998).

The aim of this study is to present the current distribution of *Orobanche ramosa* in Poland based on a critical revision of literature and herbarium data and the results of my field studies. Issues related to the taxonomy, biology, ecology and control methods of *O. ramosa* are also discussed.

TAXONOMIC NOTES

Orobanche ramosa Linnaeus 1753, Sp. Pl. 2: 633. Syn.: *O. micrantha* Wallr., *O. cannabis* Voucher ex Duby, *O. albiflora* Godr. et Gren., *Kopsia ramosa* (L.) Dum., *Phelipaea ramosa* (L.) C. A. Mey., *Phelipanche ramosa* (L.) Pomel.

Orobanche ramosa, *O. arenaria* Borkh., *O. bohemica* Čelak. and *O. purpurea* Jacq. represent the section *Trionychon* Wallr. in Poland. *O. ramosa*

is a highly variable taxon. It comprises varieties and subspecies that are increasingly often recognized as separate species, mostly based on the length and shape of the corolla and the calyx: *O. ramosa* subsp. *mutelii* (F. W. Schultz) Coutinho, *O. ramosa* subsp. *nana* (Reuter) Coutinho, and *O. ramosa* subsp. *ramosa* (Chater and Webb, 1972). The first two occur mostly in southern Europe and parasitize wild plants. *O. ramosa* subsp. *ramosa* is usually a crop parasite.

High variability is also observed within *Orobanche ramosa* subsp. *ramosa*, especially for the length or colour of flowers which may range from whitish to pale blue or intensely blue. The height and branching, if present, of shoots may also differ. The stem and inflorescence are branched in f. *polyclonos* Wallroth (var. *robusta* Čelakovsky), while f. *monoclonos* Wallroth (var. *simplex* Noulet, *Kopsia ramosa* Dum. f. *monoclonos* Béguinot, *Phelipaea ramosa* var. *monoclonos* Rouy) has a single inflorescence and stem. The colour of the corolla distinguishes f. *cyanea* G. Beck (*Kopsia ramosa* f. *cyanea* Béguinot), which has an intensely blue-purple corolla, from f. *albiflora* (Godr. et Gren.) G. Beck (*Phelipaea ramosa* var. *alba* Webb et Berthel, *Kopsia ramosa* f. *albiflora* Béguinot, *Phelypaea ramosa* var. *alba* (Webb et Berth.) Rouy) which has a white corolla. Corolla size and shape may also vary. F. *gracillima* G. Beck is distinguished by a 1-1.2 cm long corolla, while the corolla is 7 mm long in f. *proboscistyla* Bianca (*Kopsia ramosa* var. *proboscistyla* Béguinot) (Beck, 1930). These morphological differences are caused by different hosts or habitat conditions. The taxonomic rank of internal taxa within *O. ramosa* requires further investigations, including ecological-geographic and molecular examinations.

BIOLOGY, HABITAT PREFERENCES AND CONTROL METHODS

Flowering time

The species flowers from March in Southern Europe. It flowers from (VI) VIII until IX (X) in Central Europe (Kreutz, 1995; Zázvorka, 1997, 2000; Pusch and Günther, 2009). It flowers from late August until late October in Poland.

Productivity, seed dispersal and vitality

A single fruit of *Orobanche ramosa* can produce between 700 and 4 000 seeds. Every plant can produce 35 000-500 000 durable and very small seeds, leading to a dramatic increase of the *Orobanche* seed bank in the soil (Sauerborn, 1991; Buschmann, 2004). Seed shape ranges from ellipsoid to ovoid, 0.33-0.52 x 0.19-0.33 mm in size (Plaza et al. 2004). 200 000 seeds per gram can be produced (Quasem and Kasravi, 1995; Quasem, 1998). Humans, machinery, water or wind can easily disperse these seeds (Buschmann et al. 2005). Seeds can lie dormant in the soil for up to 13 years (Buschmann, 2004). Seed life expectancy in broomrapes varies considerably depending on the soil type and climatic conditions. Broomrape viability can probably be longer in drier conditions (Teryokhin, 1997).

Hosts

Orobanche ramosa is a polyphagous species recorded on different plant species. Its most common hosts include crop taxa: *Nicotiana tabacum, Cannabis sativa, Lycopersicon esculentum, Solanum tuberosum*. It is recorded less frequently on species of the genera *Capsicum, Helianthus, Rorippa, Phaseolus, Brassica, Cucurbita, Armoracia, Lens,* or on ornamental species, e.g. *Begonia, Coleus, Coreopsis, Pelargonium*, *Zinnia*, *Chrysanthemum*, *Tropaeolum*, and species of the genera *Lamium, Xanthium* and similar. It mainly parasitizes tomatoes and tobacco in Europe (Beck, 1890, 1930; Kreutz, 1995; Uhlich et al. 1995; Zázvorka, 1997, 2000; Pusch and Günther, 2009). It has recently been recorded on *Medicago lupulina* in Virginia (USA) for the first time (Musselman and Bolin, 2008). It has also been spreading in western France, where it parasitizes *Brassica napus* subsp. *napus* (Gibot-Leclerc et al. 2003).

Habitat and phytocoenoses

Orobanche ramosa occurs in root crop fields, in sown fields, fallows, sandy fields, especially in root crop cultures, on roadsides, in ruderal pastures, on alkaline, nutrient-rich sandy or loamy soil (Mądalski, 1967, Tzvelev, 1981, Kreutz, 1995).

It is mostly a lowland species. The highest site of its occurrence in Central Europe was reported from Wallis in Switzerland, at ca. 1 600 m a. s. l. (Pusch and Günther, 2009). It has also been reported from mountainous areas, e.g. from the Czech Republic (Tepelské vrchy) 650-690 m (Zázvorka, 2000), Tyrol up to 883 m, Abkhazia 850 m, northern Persia 3200 m, Eritrea 2480 m, Italy up to 1000 m (Pignatti, 1982; Uhlich et al. 1995).

In Europe the species has been recorded in Eragrostion, Caucalidion lappulae, Polygono-Chenopodietalia, Bidentetalia tripartitae, Tribulo-Eragrostion, Secalietea (Oberdorfer, 1990; Uhlich et al. 1995; Zazvorka, 2000; Jäger and Werner, 2002; Kropáč, 2006). A separate segetal community with *Orobanche ramosa* has been distinguished in Ukraine (Crimea region), Orobancho ramosae-Stachydetum annuae, Stellarietaea mediae class (Bagrikova, 1996).

Control methods

As *Orobanche ramosa* can cause considerable crop losses, a range of eradication methods have been

developed. However, it is a persistent weed and control strategies described in the literature are not always universal or fully effective. The main control methods are described below.

Some success has been obtained using chemical control (Lolas, 1994; Qasem, 1998; Borkowski et al. 2007a; Borkowski and Robak, 2000, 2002; Goldwasser et al. 2003), resistant varieties (Perez-de-Luque et al. 2004) and agronomical practices (Haidar and Sidahmed, 2000). Crop rotation for a period of at least five years is recommended in fields affected by *Orobanche ramosa* (Małuszyńska et al. 1998). Many researchers have investigated the effect of organic fertilizers on the seed germination of a variety of plants (Haidar et al. 1999; Haidar and Sidahmed, 2000). Haidar et al. (2003) reported that goat manure significantly reduced broomrape infestation. Broomrape seeds can also be destroyed by soil solarization (Abdel-Rahman and Al-Tawaha, 2005; Sahile et al. 2005).

Another control method is the use of drip irrigation systems. Results reported in the literature indicate that broomrape infestation in tobacco and potato can be suppressed by drip irrigation (Sabra, 2000; Veeraputhiran and Kandasmy, 2001; Karkanis et al. 2007).

Biocontrol methods with insects or pathogens are still being researched. Studies have been conducted on the use of *Phytomyza orobanchiae* (Diptera: Agromyzidae). *P. orobanchiae* is an oligophagous species and feeds on *Orobanche* spp. (Klein and Kroschel, 2002). The larvae of *P. orobanchia* mine in *Orobanche* shoots and capsules, feed on the seeds and also damage the stalks of the plant (Spencer, 1973). *Aphis gossypii* also stunts growth and flowering of *O. ramosa* in greenhouse conditions (Borkowski et al. 2007b).

Studies on growth-inhibiting pathogens, such as many species of the genus *Fusarium*, *Ulocladium atrum*, *Rhizoctonia solani*, *Alternaria* and *Sclerotinia* sp., are increasingly popular. *Myrothecium verrucaria* or *Fusarium compactum* were isolated from diseased *O. ramosa* plants collected, e.g., in southern Italy to find potential biocontrol agents of this parasitic weed (Zonno and Vurro, 2002; Abouzeida et al. 2004; Andolfi et al. 2005).

MATERIALS AND METHODS

All available herbarium materials of *Orobanche ramosa* in Poland and Germany deposited in herbaria GLM, KTC, KRA, KRAM, LBL, TRN, WA were reviewed. Herbarium acronyms are given after Mirek et al. (1997) as well as Holmgren and Holmgren (1998). The nomenclature of vascular plants follows Mirek et al. (2002). The nomenclature of syntaxa is based on Matuszkiewicz (2006). The localities are listed in ATPOL cartogram units, 10 x 10 km (Zając, 1978); units are given in alphabetical order. Data collected by me and the localities documented in the herbarium materials and reported in the literature are included. Abbreviations of the hosts of *O. ramosa* are based on the information in the herbarium materials and in the available literature (in brackets after the location of the site): *hc* – headed cabbage (*Brassica oleracea* subsp. *capitata*), *h* – hemp (*Cannabis sativa*), *p* – potato (*Solanum tuberosum*), *tb* – tobacco (*Nicotiana tabaccum*), *tm* – tomato (*Lycopersicon esculentum*), *s* – strawflower (*Helichrysum bracteatum*), *u* – stinging nettle (*Urtica dioica*).

During the floristic investigations conducted between 2008 and 2010, two new localities of *Orobanche ramosa* were recorded: in the Płaskowyż Proszowicki plateau (Wyżyna Małopolska upland) and the Nizina Nadwiślańska lowland (Kotlina Sandomierska basin) (Fig. 1). The location of these sites, the abundance of individuals within populations and the preferred host at the new localities are specified, and the habitats are briefly described. Soil tests were performed at the Regional Chemical-Agricultural Station in Kielce.

Specimens collected at the new localities were deposited in the Herbarium of the Jan Kochanowski University in Kielce (KTC).

RESULTS

Distribution in Poland

Orobache ramosa occurred in Poland at a few scattered localities, mostly in the lowland, in Pomerania, Kujawy, Wielkopolska, Silesia, the Wyżyna Małopolska upland, the Nizina Sandomierska lowland, Wyżyna Lubelska upland, Podkarpacie, in Podolia and Volhynia within the Polish borders in the interwar period (Szafer et al. 1924; Mądalski, 1967; Fijałkowski, 1995; Zając and Zając, 2001) (Fig. 1). A vast majority of data were reported in the late 19th and the early 20th centuries. The species has not been observed in recent years; only a massive occurrence of *O. ramosa* in several tomato crops in the Sandomierz region in 1999 was reported but the location was not specified (Borkowski and Robak, 2000, 2002).

List of localities: AC: **02** – Gryfino, (*h*, *tb*), Müller W., 1911; **03** – Wirów, (*h*, *tb*), Müller W., 1911; **40** – Siekierki, Altmann P., 1894, Huth E., 1895, 1909; **68** – Czechów near Gorzów Wielkopolski, (*tb*), Rebentisch J. F., 1804; **79** – Skwierzyna, Ascherson P., 1864; **AD**: **03** – Kunowice, Schlechtendahl D. F. L., 1823; Dietrich A., 1824; Ruthe J. F., 1827; **35** – Osiecznica, (*tb*), Decker P., 1911; **BD**: **30** – Smolno, (*tb*), Decker

W., 1911; **53** – Przybyszów near Sława Śląska, (*h*), leg. Wätzold and Grinperinte, 07.1870 (WA); Limpricht G., 1871; Fiek E., 1881 (after Wätzold); Schube T., 1903; **72** – Kotla, (*h*), Fiek E., 1881 (after Tappert W.); **76** – Czernina, (*h*), Fiek E., 1881 (after Starke J. C. – probably before 1800); **BF**: **07** – secondary school garden, Ząbkowice Śląskie, (ornamental *tb*), Schube T., 1930; **CB**: **99** – Chełmno, (*h*), Klinggräff C. J., 1862 (after Wacker H.); **CC**: **09** – on the Fryba river near Chełmno, (*h*), Wacker H., 1862; Abromeit J. et al., 1898 (after Wacker); **CF**: **66** – Bojanów near Racibórz, (*h*), leg. Kelch, 18..?, (GLM, 106745, 138785; WA 36740); Wimmer F. and Grabowski H., 1829, Wimmer F., 1841, 1857, 1868; Fiek E., 1881; Schube T., 1903; **67** – Ligota Tworkowska, (*h*), Fiek E., 1881; **DA**: **80** – Gdańsk, Abromeit J. et al., 1898 (after Seid. herb.), 1903 (after Klatt, 1860); **81** – Sobieszewo (*h*), Preuss H., 1910; **DC**: **31** – Toruń-Kaszczorek, (*h* or *p*), leg. Boruss H., 18.. (TRN); Klinggräff C. J., 1854, 1866; Abromeit 1898 et al. (after Nowicki J.); **DF**: **48** – between Wola Kalinowska and the Kalinów manor, (*h*), leg. Michalik S., 17.08.1965 (KRAM, 456148); Michalik S., 1978; **66** – Kwaczała, (*h*), leg. Gustawicz B., 19… (KRAM); **69** – Bronowice, (*h*, *p* or others *Solanaceae*), Berdau F., 1859; Knapp J. A., 1872; Wola Justowska, Raciborski M., 1884 (after Dembosz's herbarium); **90** – Cieszyn, (*h*), Schube T., 1903; **ED**: **27** – Wilanów and Służew districts in Warsaw, (*h*), Grochowski W., 1931; **51** – Rawiczów near Skierniewice, (*p*), vid. Dyki B., ca. 1960 (after Borkowski and Dyki 2008); **EF**: **25** – Łatanice near Busko Zdrój, (*tb*), leg. Jasiewicz A., 30.09.1955 (KRAM, 413634, 413636, 413635, 413633, 019545, 088313); **60** – Mogiła, the edge of field, (*u*), leg. Żmuda A., 11.09.1909 (KRAM, 061502); Kraków-Mogiła, (*s*), leg. Guzik J., 18.08.1986 (KRAM, 406533); **62** – Wola Batorska, Raciborski M., 1884; **67** – Tarnów, (*h*, *p*), Knapp J. A., 1872; Wayda M., unpbl 1990, 1992 (ATPOL data); **EG**: **08** – Zagórzany, (*h*, *p*), Knapp J. A., 1872; **32** – Czorsztyn, Zarzycki K., 1981 (based on the herbarium specimen collected by Fritze R., 06.09.1865, WRA); **FD**: **48** – Piszczanka, Międzyrzec Podlaski commune, (*h*), Eichler B., 1883; **FE**: **13** – Puławy, leg. XX, 1946 (LBL); Fijałkowski D. unpbl, 1973; Włostowice (an estate in Puławy), (*h*), leg. Cinger N., 15.08.1910 (KRA, 0236228); **18** – Niemce near Lublin (arable fields), leg. Fijałkowski D., 08.09.1971 (LBL); **23** – Kazimierz Dolny, (*tb*), Fijałkowski D. unpbl, 1959; leg. Fijałkowski D., 12.07.1947 (LBL); **29** – Żurawniki, (*h* or *p*), Knapp J.A., 1872; **FF**: **56** – Białobrzegi, Kulpa W., 1964; Dubiel et al., 1979 (after Kulpa) [Kulpa reports that it occurred abundantly in several crops of *tb* and on *hc* in 1954, and its mass occurrence was observed in a patch of *h* in 1959); **FG**: **16** – Sanok, (*h*), Knapp J. A., 1872; leg. Piech K., 02.09.1923 (KRAM, 095383, 095384); **GE**: **23** – under Góra Stawska Mt near Chełm, (*h*), leg. Karo F., 28.08.1884 (WA); **34** – Chełm, (*h*) leg. Karo F., 26.08.1884 (WA); **42** – Żulin, (*h* or *p*), Knapp J. A, 1872; **55** – Krasne near Turowiec, Fijałkowski D. unpbl, 1967; **62** – Krasne near Izbica (arable field), leg. Fijałkowski D., 15.06.1974 (LBL); **GF**: **20** – Różaniec, Fijałkowski D. unpbl 1972, publ. 1995; **21** – Osuchy, Fijałkowski D. unpbl 1957, publ. 1995; **81** – between Starzawa and Buców (most probably in the Ukrainian part), Kotula B., 1881; **90** – near Grochowce, (*h*), Kotula B., 1881; **GG**: **00** – near Fredropol, (*h*), Kotula B., 1881. *locality difficult to locate on the map: Pawłów, (*h*), leg. Prof. Polański, 08.1918 (KRAM).

New localities of *Orobanche ramosa*

1. Płaskowyż Proszowicki plateau, Zysławice.

The locality is in a field, in a tobacco crop, Zysławice village near Wojsławice, S of Kazimierza Wielka, on loamy-sandy soil. Soil pH is alkaline (pH in KCl = 7.3), the content of P is very high (31 mg/100 g soil), Mg – medium (6.7 mg), and a low content of K (10.9 mg). The broomrape was observed intermittently by the field owners for over 20 years. Broomrape infestation occurred only when tobacco was planted as part of crop rotation. *O. ramosa* is accompanied by its host and common weeds: *Galinsoga parviflora, Echinochloa crus-galli, Elymus repens, Chenopodium album, Polygonum aviculare, Equisetum arvense, Setaria pumila, Convolvulus arvensis.* The community may be included in the Polygono-Chenopodietalia order (Stellarietea mediae class) with species belonging to the Agropyretea intermedio-repentis class. Over fifty, mostly large tufts consisting of ten to some 30 shoots, were recorded. The flowering optimum was observed in the second half of August and in the first half of September 2008. Individual specimens also flowered in late September and early October. ATPOL: EF53; GPS: 50°11'25.1''N, 20°30'58.7''E, 220 m a.s.l.

2. Nizina Nadwiślańska lowland, Szewce.

The locality is ca. 0.5 km SE of the S border of the Szewce village, in the Vistula valley. The field borders on an unnamed tributary of the Koprzywianka river to the east. Over 1 000 specimens of *O. ramosa* occur in a tomato crop covering an area of ca. 150 m^2. It is accompanied by common weeds: *Chenopodium album, Echinochloa crus-galli, Capsella bursa-pastoris, Stellaria media, Galinsoga parviflora*. Observations were conducted on 25.09.2010. Ca. 50% of the population was withered; the remaining population was in full bloom or was beginning to flower. ATPOL: FE91; GPS: 50°37'37.6''N, 21°37'44.2''E, 129 m a.s.l.

A historical outline of preferred hosts of *Orobanche ramosa* in Poland

Orobanche ramosa was probably introduced to Central Europe shortly after hemp cultivation began and can be regarded as an archaeophyte (traces of hemp cultivations date from the Iron Age ca. 500 BC) (P u s c h and G ü n t h e r , 2009). The oldest information concerning the use of hemp goes back to China, ca. 5500-4500 BP. Hemp spread in Asia and reached Europe through Scythian tribes who used it as a drug. As in Europe, the oldest records of hemp in Poland were described from the Roman period but the plant gained importance in the early Middle Ages (L i t y ń s k a - Z a j ą c , 1997; L i t y ń s k a - Z a j ą c and W a s y l i k o w a , 2005). Tobacco was imported from North America (in Europe since ca. 1560) and the parasite was probably distributed in Central Europe with its seeds (P u s c h and G ü n t h e r , 2009).

First documented reports on its occurrence in Poland date back to the beginning of the 19th century from a hemp crop (F i e k , 1881, after Starke – probably before 1800) and a tobacco crop (R e b e n t i s c h , 1804). However, the most abundant records were observed between the 1850s and the 1960s in hemp crops where it reached the occurrence optimum in Poland. Less numerous occurrence has also been reported from tobacco and potato crops. It has been reported from a single locality on stinging nettle, strawflower and on headed cabbage. At present, it is observed only on tobacco and tomatoes as hemp cropping has been discontinued. Based on available data on the hosts of *O. ramosa*, a diagram of individual host species is presented, specifying the time and the number of localities (Fig. 2). A considerable drop in the number of localities (the disappearance) of *O. ramosa* in recent years is also caused by more efficient methods of seed purification, crop rotations and the application of plant varieties resistant to infection. Similar causes of the disappearance of the species have been described from the Czech Republic after hemp cultivation was discontinued in the 1950s and following the quarantine act in 1964-1996 (Z á z v o r k a , 2000).

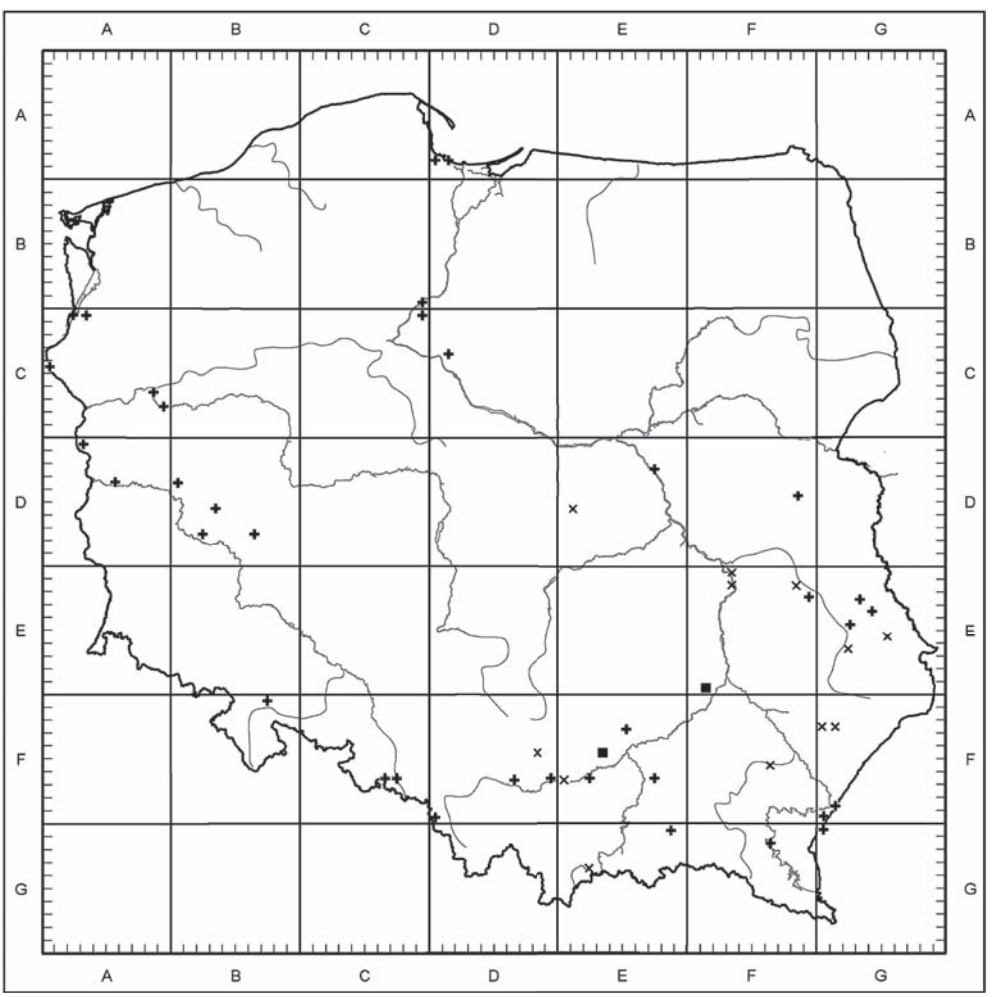

Fig. 1. Distribution of *Orobanche ramosa* L. in Poland (after Zając and Zając 2001, in ATPOL grid 10 x 10 km), modified and supplemented; ■ – new locality, × – locality not confirmed at present, probably extinct, + – extinct locality.

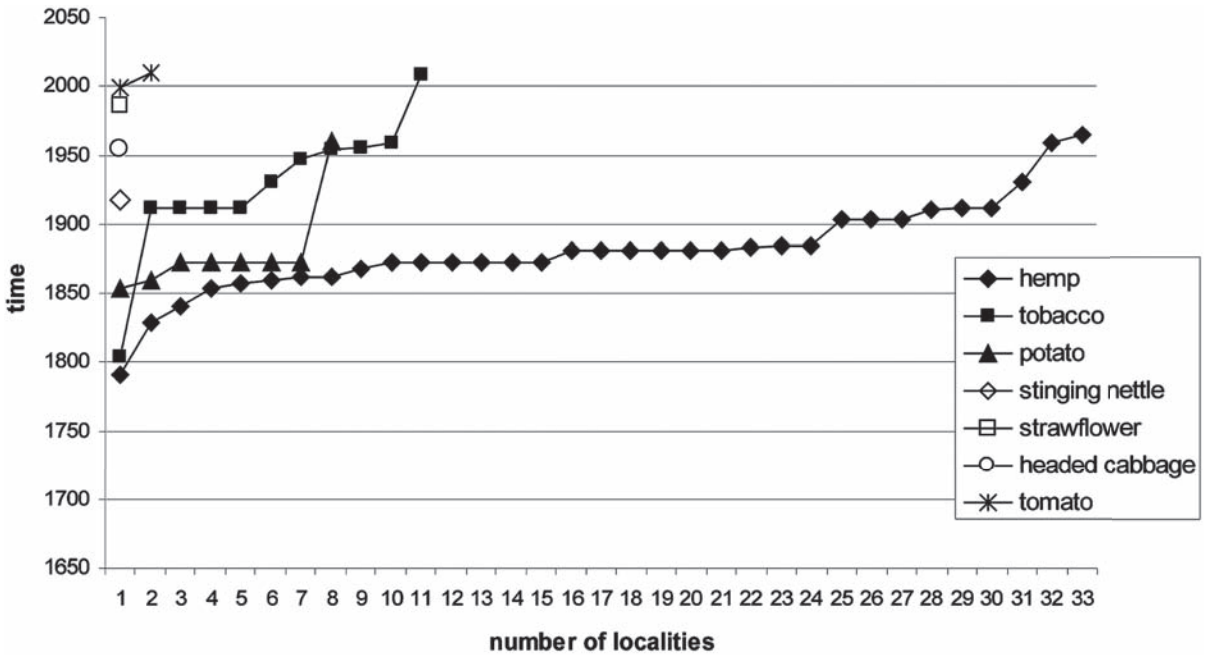

Fig. 2. A comparison of preferred hosts of *Orobanche ramosa* and the time and number of localities recorded in Poland.

DISCUSSION

Orobanche ramosa in Poland, also in Central Europe, is probably an archaeophyte. The first documented reports on the occurrence of *O. ramosa* in Poland date back to the early 19th century, mostly from hemp, tobacco and potato cultivation. Its preferred habitats include root crops where host species occur as well as tobacco and tomatoes, in communities of the Polygono-Chenopodietalia order (Stellarietea mediae class) at the newly discovered localities.

The flowering optimum was observed at the new sites between late August and late September (October). The species did not flower homogenously. Withered specimens and specimens flowering or beginning to flower occurred simultaneously in individual populations. *O. ramosa* sporadically occurs singly; it usually grows in tufts consisting of between several and some 30 shoots.

As reported by local residents in the Szewce village and its vicinity, *Orobanche ramosa* usually occurs more abundantly in dry summers. Farmers have noticed a drop in tomato fitness when mass infection by the parasite takes place. In 2010, however, an abundant occurrence of *O. ramosa* in a tomato field was also observed in a post-flood area.

An analysis of the distribution map in Poland shows that the species mainly occurs along the valleys of larger rivers (Fig. 1) and it may have spread during spring and autumn floods. Humans, however, play a role in the geographic spread of *O. ramosa*. Transport and seed exchange of host species are also important factors. Broomrape invasion into natural habitats or considerable crop losses have not been recorded in Poland to date. However, broomrapes often cause considerable economic losses in warmer climates. *O. ramosa* is a considerable threat to tomato crops in many countries, e.g. Turkey, Lebanon, Israel, Jordan, Sudan, Ethiopia (Saghir et al. 1983; Dongola, 1995; Qasem, 1998; Sahile et al., 2005). It is especially noxious in tobacco fields in many countries in the Middle East, northern Africa, Cuba and Chile (Abu-Irmaileh, 1994, Kogan, 1994, Labrada, 1994). Numerous studies are conducted worldwide to control and eradicate the parasite.

The majority of Polish species of *Orobanche* are rare and threatened plants that do not cause crop losses. All species of the genus *Orobanche* are strictly protected in Poland (Regulation of the Minister of Environment of 24th July 2004). *O. ramosa* has not caused considerable crop losses so far and is a disappearing species in Poland. It is no longer listed as a quarantine parasite. However, the species should be closely monitored, especially near Sandomierz, one of the largest regions of vegetable production in Poland. A land register should be maintained to monitor the spread of *O. ramosa*. Poland participates in the international COST849 research programme investigating parasitic plants, including *Orobanche*, and control methods of plant parasites in crops (Borkowski and Dyki, 2008).

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Rewizja rozmieszczenia i historyczna analiza preferowanych żywicieli *Orobanche ramosa* (Orobanchaceae) w Polsce

Streszczenie

Orobanche ramosa, zaraza gałęzista, znana była od dawna w Europie Centralnej, jako pasożyt upraw konopi i tytoniu, i nie miała dotychczas poważniejszego znaczenia gospodarczego. Jednak w ostatnich latach staje się agresywnym chwastem, adaptuje się do nowych żywicieli i powoduje znaczne straty w uprawach. W Polsce należy do gatunków o rzadkich lub od dawna nie potwierdzonych stanowiskach. Pierwsze udokumentowane wzmianki o pojawieniu się zarazy gałęzistej w Polsce pochodzą z początku XIX w., głównie z upraw konopi, gdzie miała optimum występowania, a także z tytoniu i ziemniaków. Preferowane siedliska to uprawy okopowe z udziałem gatunków żywicielskich, w zbiorowiskach należących do rzędu *Polygono-Chenopodetalia* (klasa *Stellarietea mediae*). W latach 2008-2010, gatunek ten stwierdzono tylko na dwóch stanowiskach w kraju: w uprawie tytoniu w okolicy Zysławic (Płaskowyż Proszowicki) oraz koło wsi Szewce (Nizina Nadwiślańska), w uprawie pomidorów. Populacje liczyły od kilkuset do ponad 1 000 pędów. *O. ramosa* jak dotąd, nie powodowała i nie powoduje znacznych szkód w uprawach, jest gatunkiem ginącym w Polsce. Jednak z uwagą należy obserwować ten gatunek, zwłaszcza w okolicy Sandomierza, jednego z największych regionów upraw warzywniczych w Polsce.