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Orobanche purpurea on its newly discovered site near Zatoń Dolna (NW Poland): the problem of protection of a threatened parasitic plant species

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Abstract: A newly discovered local population of *Orobanche purpurea* in NW Poland is described. It was composed of 141 specimens when first found in 2007 on fallow land near the village of Zatoń Dolna. However, the size and distribution of this population changed considerably during the last three growing seasons. The remarkable decline in population size is probably due to competition of other species with the host plant, *Achillea millefolium*, and the effect of the parasite itself, which weakens its host.

Key words: *Orobanche purpurea*, population dynamics, survival rate

1. Introduction

Orobanche purpurea (yarrow broomrape), like other species of the family Orobanchaceae associated with dry sunny sites, is one of the most threatened, declining elements of the flora of northern Europe (Rumsey & Yury 1991; IUCN Red List 2009). Its very scattered distribution in this part of Europe and the generally small size of its local populations, which are isolated and found on fragmented or disappearing sites, as well as its specific development and metabolism (Yodler 2001) all result in the lack of stability of its gene resources. In Poland, *O. purpurea* is extremely rare, included in the Red List of Plants (Zarzycki & Szeląg 2006) and in regional red lists (Nowak *et al*. 2003; Kącki *et al*. 2003; Jackowiak *et al*. 2007).

Protection of rare parasitic species is a complex problem. First, it is necessary to analyse the relations between the host (or hosts) and the parasite. Consequently, attempts should be made to preserve the plant communities in which host plants can be found (Marvier & Smith 1997). However, the plant community transformations that are unfavourable for parasites, are to a large extent caused by parasites themselves (Press & Phoenix 2005). The aim of this study was to describe the population of *O. purpurea* on its newly discovered site near Zatoń Dolna, and to assess the possibility of its survival under the influence of changes in environmental conditions.

2. Material and methods

Orobanche purpurea Jacq. (= *Phelypaea caerulea* (Vill.) C. A. Meyer, *Orobanche coerulea* Vill.) is a parasite of plants, mostly of *Achillea* spp. but sometimes of *Artemisia* spp., found on dry sunny grasslands (Mądalski 1967). It produces erect, sturdy, and usually unbranched shoots, covered with small, elongated scales. The shoots are bluish, with glandular hairs, and are 15-60 cm high. From May to August, *O. purpurea* develops a cylindrical apical inflorescence, which is a loose raceme. The bell-shaped, yellowish calyx with 4-5 lobes, is located at the axil of an elongated, narrow bract, which is about as long as the calyx. Corolla is pale blue or violet-blue with darker veins, 20-35 mm long, whitish-yellow at base, its upper part slightly curved forwards. The upper lip is divided into 2, while the lower lip into 3 elliptic lobes with nearly entire margins. Anthers are glabrous or slightly pubescent, stigma 2-lobed, white or light purple. Fruit is an oval capsule, containing very numerous fine seeds. Seeds dark brown, ovoid-ellipsoid. Epidermal seed sculpture

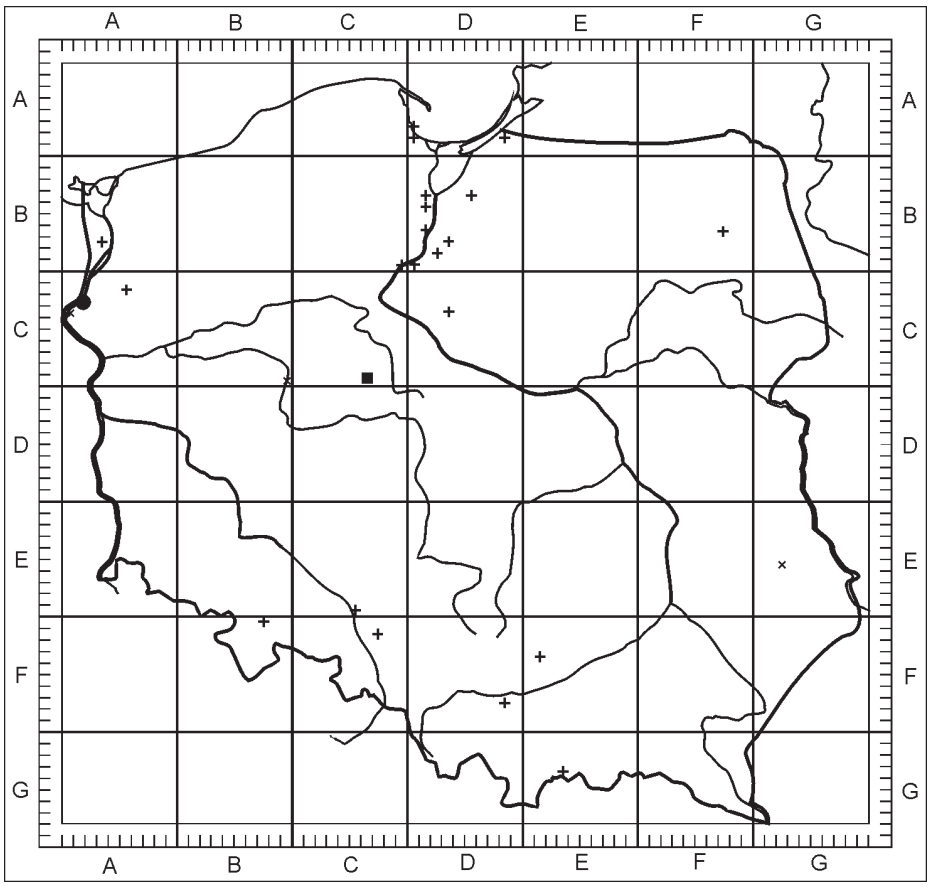

Fig. 1. Distribution of *Orobanche purpurea* in Poland (in ATPOL grid 10×10 km, according Zając & Zając 2001, modificated)
Explanations: ● – new site, ■ – the locality was confirmed in the 1990s, + – extinct station, × – station not confirmed at present

reticulate, formed by periclinal and anticlinal walls, with fibres visible from the outside, surrounding depressions of various depth. Chromosome number 2n = 24 (according to Rumsey & Yury 1991).

Orobanche purpurea is a Central European Pontic-Pannonian species. Its natural range extends from North Africa through the Iberian Peninsula and Central Europe to the central part of the British Isles and southeastern

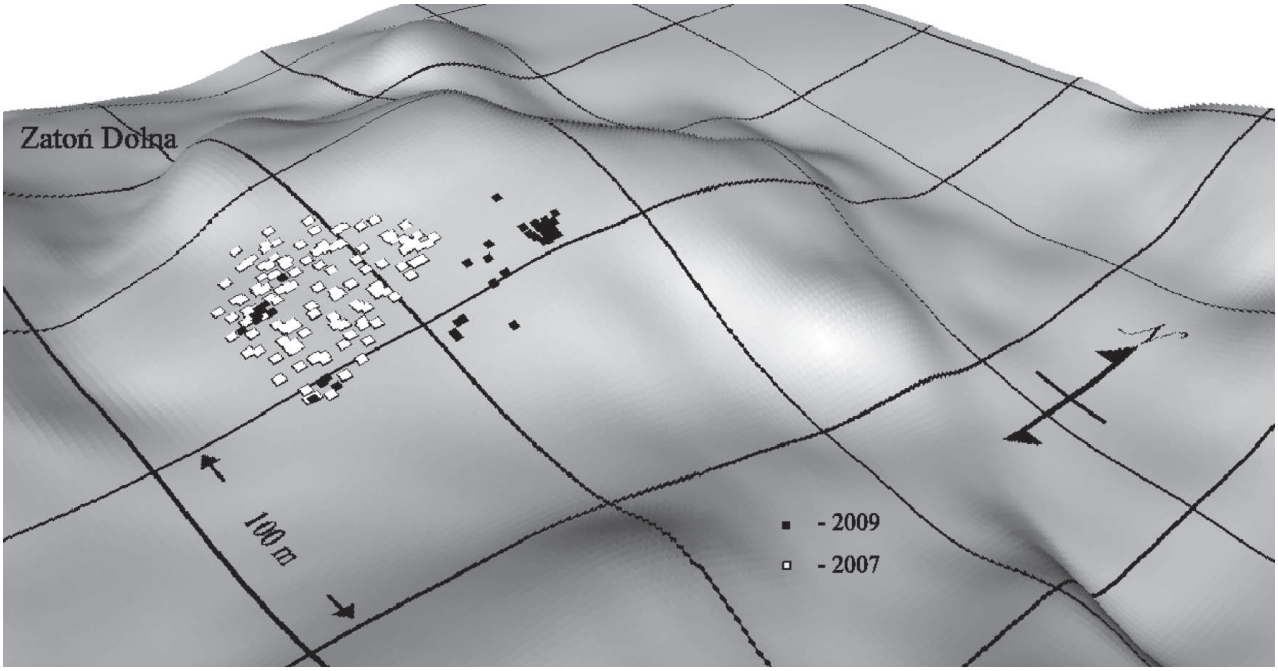

Fig. 2. Location of the new site of *Orobanche purpurea* and distribution of its individuals (in 2007 and 2009) on a slope near Zatoń Dolna

Sweden in the north, and next to eastern Europe and southwestern Asia (Chater & Webb 1972).

In Poland it has been recorded so far in the valleys of the Vistula and Oder, in the uplands (Małopolska, Silesian and Kraków-Częstochowa Uplands), as well as in the Gniezno Lakeland and the Biebrza National Park (Chmiel 1987; Wróblewska 2000; Zając & Zając 2001) (Fig. 1).

Field observations of *O. purpurea* in Zatoń Dolna were made during its flowering period, in late June 2007 and in early July 2009. Each year, its shoots were counted, shoot height was measured, and their distribution was plotted by means of GPS. In the patches with the largest contribution of *O. purpurea*, phytosociological data were collected in 5 relevés (2 in 2007 and 3 in 2009), according to the classic Braun-Blanquet method. The names of syntaxa follow Matuszkiewicz (2001), while plant names follow Mirek *et al.* (2001). Calcium carbonate content of soil samples was determined by Scheibler's method (Ostrowska *et al.* 1991). In Fig. 2, showing the distribution of individuals, the model of the study area was prepared on the basis of a 1:10 000 map, by TNTmips software.

3. Results and discussion

In Pomerania, *O. purpurea* was recorded on several historical sites: Kończyce near Nowe and Morgi Dolne (Abromeit *et al.* 1898-1940), Pelplin, Nowe, Sopot, Stegny (Lakowitz 1925), Westerplatte (Dietrich 1836, herbarium UGDA), Golęcin (Müller 1911), Pyrzyce (Szmajda 1968, herbarium POZ), and in the forest-steppe reserve "Bielinek" (Celiński & Filipek 1958). The last site has not been confirmed by recent research (Zając *et al.* 1992; Załuski 2000), while the specimen collected in Pyrzyce proved to be misidentified (Renata Piwowarczyk, oral comm.).

In 2007, a large population of *O. purpurea* was found at the edge of the Oder river valley, near Zatoń Dolna (Fig. 2), within the Cedynia Landscape Park (Special Area of Conservation: Dolna Odra PLH 320037). The new site of *O. purpurea* is located on a northeastern, gently (ca. 1°) inclined slope of a hill (53°00'39-43 N, 14°16'55-58" E; ATPOL: AC 2110) (Fig. 1).

On fallow land partly covered by dry grass communities with xerothermic species, 141 individuals of *O. purpurea* were found. They parasitized *Achillea millefolium* (Fig. 3). The parasites formed 47 groups of up to 5 individuals, but most often composed of 3 individuals. They were up to 0.45 m high, and their mean height was 0.37 m. In 2009, the *O. purpurea* population was smaller: 51 individuals, scattered in 39 places. They usually occurred singly, sometimes in pairs, and rarely in groups of 3-4 individuals. Their height was also smaller: only 1 shoot was 0.48 m high,

Fig. 3. *Orobanche purpurea* in the new locality in Zatoń Dolna
A – parasitizing on *Achillea millefolium*, B – inflorescence (photograph by J. Prajs, 23.06.2007)

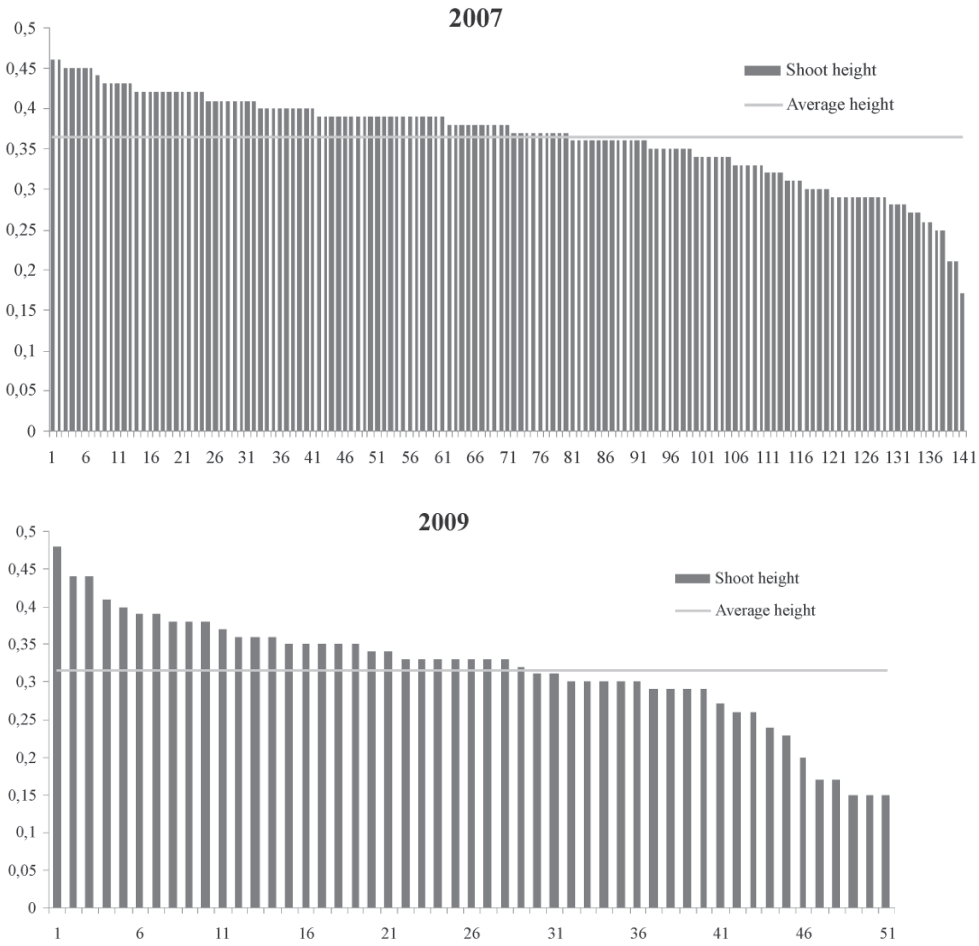

Fig. 4. Height of shoots of *Orobanche purpurea* near Zatoń Dolna in 2007 and 2009

2 were 0.44 m high, while the mean height was 0.32 m (Fig. 4).

O. purpurea appeared in patches of vegetation developed on a loamy site, on old fallow land, probably 4 years after it was cultivated with a disk harrow for the last time (oral comm.). The plant communities occupied very sandy sites, with calcium carbonate content of about 0.17%. They were mostly composed of meadow species and xerothermic plants, including: *Linosyris vulgaris*, *Anthemis tinctoria*, and *Origanum vulgare* (Table 1, relevés 1-3).

The communities are very dynamic. During the 3 growing seasons, proportions between plant species in those patches changed considerably. The contribution of plants of the class *Festuco-Brometea* decreased, in contrast to an increase in the abundance of *Agropyron repens* and of plants of the class *Artemisietea* (Table 1, relevés 4, 5). However, the decrease in the population size of *O. purpurea* did not seem to be related to the density of the host plant, *Achillea millefolium*, which did not differ considerably during this study. Moreover, the distribution of *O. purpurea* also changed. It disappeared completely from most of the places where it was most abundant, and appeared nearby, where it was not observed previously (Fig. 2).

Orobanche purpurea, due to its rarity in Poland, has no defined syntaxonomic position (in the phytosociological classification). In studies from Central Europe, only general information can be found about communities where the species was recorded, e.g. xerothermic grasslands, dry grassland on calcareous soils and ruderal communities (Chmiel 1987; Rumsey & Yury 1991; Krebs & Otto 1999; Wróblewska 2000), but usually no phytosociological data from relevés are provided to document these plant communities. In Germany, Oberdorfer (1970) classified *O. purpurea* as an element of mesoxerophilic grasslands (*Mesobromion*) or fresh meadows (*Arrhenatherion*).

On the morainic hills near Zatoń Dolna, fallow land is usually dominated by grass communities, which are similar to xerothermic grasslands because of the presence of some xerothermic species, which are widespread in this area. The contribution of *O. purpurea* in those patches as well as their floristic composition and spatial distribution change in time (Fig. 2). However, even a drastic decrease in local population size or a

Table 1. Floristic composition of the community with *Orobanche purpurea*, on its new site near Zatoń Dolna

Number of relevés	1	2	3	4	5
Data	25.06.07	5.07. 09	25.06.07	5.07. 09	5.07.09
Exposition	NE	NE	NE	NE	NE
Relevé area [$m^{2]}$	60	40	60	40	40
Cover of layer [%]	100	100	100	100	100
Number of species in relevé	17	30	16	19	18
Orobanche purpurea	2	1	2	+	1
Ch. C. *Molinio-Arrhenathereatea*					
Achillea millefolium	3	3	3	1	3
Daucus carota	1	1	3	+	1
Festuca pratensis	+	+	+	+	+
Poa pratensis	+	+	+	+	+
Arrhenatherum elatius	1	.	.	.	2
Dactylis glomerata	+	+	+	.	.
Trifolium repens	.	+	.	.	+
Cerastium holosteoides	.	.	.	.	+
Vicia cracca	.	.	.	+	.
Bromus hordaceus	.	.	.	+	.
Ch. C. *Festuco-Brometea*					
Galium verum	1	+	1	+	+
Anthemis tinctoria	1	1	2	+	.
Linosyris vulgaris	1	+	1	+	.
Centaurea rhenana	+	+	+	.	.
Artemisia campestre	.	.	.	1	+
Medicago falcata	.	+	.	+	.
Falcaria vulgaris	.	+	.	.	.
Veronica spicata	+	.	.	.	.
Ch. C. *Trifolio-Geranietea*					
Origanum vulgare	.	2	2	1	1
Vicia tenuifolia	.	+	+	.	1
Campanula rapunculoides	+	+	.	.	.
Ch. C. *Koelerio-Corynephoretea*					
Hypocheris radicata	.	.	.	.	1
Vicia lathyroides	+	.	.	.	.
Helichrysum arenarium	.	+	.	.	.
Hieracium umbellatum	.	.	.	+	.
Ch. C. *Artemisietea*					
Artemisia vulgaris	.	+	2	.	1
Tanacetum vulgare	+	1	.	.	1
Cirsium arvense	.	+	+	+	.
Melandrium album	.	+	+	.	.
Ch. C. *Stelarietea mediae*					
Apera spica-venti	.	+	.	.	.
Consolida regalis	.	+	.	.	.
Papaver argemone	.	+	.	.	.
Myosotis arvensis	.	+	.	.	.
Others		+			
Agropyron repens	2	1	1	4	2
Conyza canadensis	.	+	.	1	.
Hypericum perforatum	.	+	.	1	.
Convolvulus arvensis	.	+	.	.	.
Solidago virgaurea	.	.	.	+	.
Agrostis vulgaris	.	.	.	.	1
Fraxinus excelsior	.	.	.	.	+
Senecio jacobea	+	.	.	.	.

periodical absence of this species does not necessarily mean that it disappeared completely. In Stolpener Burgberg (Saxony), on a historical site confirmed in 1989, after nearly 150 years since its discovery, observations were made for 10 years and considerable fluctuations were detected in the size of *O. purpurea* population that parasitizes *Artemisia vulgaris*.

An increase in population size in Saxony seemed to be associated with favourable weather conditions, i.e. high temperatures or high precipitation in summer, while periodical disappearance of this species coincided with an absence or remarkable decline of the host plant population (Krebs & Otto 1999). According to Press & Phoenix (2005), the parasite-host system is particularly

sensitive to changes in site conditions. The parasite also lowers the ability of the host plant to compete with other plant species. This undoubtedly affects the rate of floristic changes in the patches of communities including this species, causing a decline in the number of host plants. As a result of this, the potential spread of the parasite is also limited (Press & Phoenix 2005).

Thus the observed drastic decrease in the local population size of *O. purpurea* near Zatoń Dolna may be transitional. However, it cannot be excluded that this trend will persist, as one of the major factors negatively affecting the population size may be the transformation of still unstable habitat, due to development of tall grasses and herbs as well as shrubs, which compete with *A. millefolium*. Because of the rarity of *O. purpurea* in Poland, this newly discovered population should be monitored and, at least in its part, the growth of host plants should be promoted by means of active protection.

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