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Active *ex situ* protection and reestablishment of *Dianthus gratianopolitanus* Vill. in the "Goździk siny w Grzybnie" reserve (Wielkopolska Province)

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Abstract: The following paper presents the results of observations of the size and condition of cheddar pink (*Dianthus gratianopolitanus* Vill.) population in the "Goździk siny w Grzybnie" reserve (Wielkopolska Province), as well as active cultivation of the species in *ex situ* controlled conditions and its reestablishment supporting the natural, endangered population in the reserve.

Key words: *Dianthus gratianopolitanus*, *ex situ* conservation, reestablishment

1. Introduction

More and more species are threatened with extinction due to radical changes in vegetation under various human activities (Kornaś 1976; Piękoś-Mirkowa 1990; Kojs 2013). Key elements of protection of plants threatened with extinction, except *in situ* protection of species by law, are monitoring and active *ex situ* conservation of their most endangered populations. In Poland, *Dianthus gratianopolitanus* Vill. is a vulnerable species (VU), strictly protected by law, although in some parts of the country it has a different threat status (Olaczek 2011). This species has been added to the group of critically endangered plants in the Wielkopolska region (CR) (Jackowiak *et al.* 2007).

Dianthus gratianopolitanus belongs to the suboceanic element of the Europeantemperate zone (Meusel & Mühlberg 1971-1978; Rothmaler *et al.* 2005). Its compact range comprises western and northern parts of the Alps. Apart from this location, it has scattered localities occurring from west France and southern part of Belgium, through Germany and Czech Republic, up to southern Poland and western Ukraine (Meusel *et al.* 1965). Through Poland leads the northern border of its distribution area.

In Poland, *Dianthus gratianopolitanus* has been reported till now from few, scattered locations with relatively small populations, mostly from the Lower and Upper Silesia, Wielkopolska Province and Małopolska Upland). Altogether, 36 localities of this species are currently known, from which only 14 are treated as confirmed: Lubuskie Province – 3 (Czwałga & Wasielewski 2002; Sajkiewicz 2003, 2005); Wielkopolska Province – 1 (Węglarski & Jańczyk-Węglarska 2000); Mazovia Province – 1 (Ferchmin & Torzewski 2011); Łódź Province – 5 (Olaczek 2011); Opole Province – 2 (Nowak & Spałek 2002; Kozak *et al.* 2005); Silesia Province – 1 (Hereźniak 2002); Świętokrzyskie Province – 1 (Łazarski 2011).

Cheddar pink belongs to characteristic xerothermic species preferring calcareous and rocky grasslands of the alliance *Seslerio-Festucion duriusculae* Klika (1931) 1948 (Rothmaler *et al.* 2005; Matuszkiewicz 2001). Habitat conditions conducive to the cheddar pink appearance can also be found in very well-lit coniferous forests, belonging to the alliance *Dicrano-Pinion* Libb. 1933 (Zarzycki 1984; Zarzycki *et al.* 2002; Czwałga & Wasielewski 2002; Sajkiewicz 2003). It grows also in gaps among old pine woods, on acid soil, in oak forests classified as *Calamagrostio arundinaceae – Quercetum*

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petraeae (Hartm. 1934) Scam. et Pass. 1959 community. In spite of the fact that some attempts were made to divide *Dianthus gratianopolitanus* into varieties in other geographic areas (Kovanda 1982), they were intentionally not used in this work. A separate taxonomic paper concerning this species diversity in Poland is in preparation.

Our work was based on the assumption that cultivation in controlled ex situ conditions and reestablishment of the most endangered populations can be an effective method of rare and endangered species protection.

The aims of this study were to support the endangered natural population of *Dianthus gratianopolitanus* with specimens originating from the preservative cultivation in the Adam Mickiewicz Botanical Garden in Poznań from seeds collected in the "Goździk siny w Grzybnie" reserve and to develop methodology of the ex situ cultivation of this species.

2. Material and methods

The *in situ* and ex situ research of *Dianthus gratianopolitanus* was carried out in 1999-2012. The structure of population and also the estimation of the degree and form of the endangerment have been measured. The plants grown in the Adam Mickiewicz Botanical Garden in Poznań from the seeds collected in the reserve (Węglarski & Jańczyk-Węglarska 2000) were used for vegetative reproduction and, next, for reestablishment and preservation of the species gene pool in the controlled *ex situ* conditions. The method of spring planting of two-years-old rosettes developed from new annual growth of rhizomes was used.

The species reestablishment was carried out in 2004 based on the protection plan (Borysiak *et al.* 2003), prepared at the request of the Governor of Wielkopolska Province. The location was formerly prepared by the forest service officers of the Konstantynowo Forest District. Black cherry (*Padus serotina* Ehrh.) underbrush was removed from this area and a barrier to protect natural population of *Dianthus gratianopolitanus* was made from pine logs and saplings of *Betula pendula* Roth. In the present study, some materials were used from the MA Thesis by Zaran-Jaszczak (1995), conducted under the supervision of the authors.

3. Results and discussion

3.1. Morphology of development

Cheddar pink is a perennial plant, producing loose, blue-green turf with clearly separated concentrations of shoots. They are built out of multi-node vegetative rosettes and leafy, half-rosette generative shoots with 2-3 leaf nodes on flowering stems. New shoots grow out of adventitious buds, located in the leaf axils of vegetative rosettes or at the bases of half-rosette shoots – from their leafless, nearest to the soil, above-ground nodes. Underground nodes of these shoots produce few adventitious roots.

String-like, multi-axially branched underground rhizome and a quite complex primary root system reaching up to 50 cm are the permanent parts of a plant. New rhizome branches together with the aboveground wintering vegetative rosettes grow in late Summer/beginning of Autumn from underground adventitious buds situated on 3-5 years old parts of rhizomes. Out of their nodes, a relatively strong system of adventitious roots develops. Annual rhizome growth dies after ca. 7-8 years, which contributes to the disintegration of a polycormic form into offspring plants.

3.2 Condition of natural population in 1960-2012

For many years, the studied population was characterized by small but stable numbers of individuals. In 1960, the population consisted of about 20 polycormic specimens of various size (Wolska 1960).

In 1995, 29 polycormic specimens in 3 locations separated from each other by ca. 10-15 m were found in the reserve. Their diameter ranged from 50 to 200 cm. However, large clusters with a diameter of 100-160 cm prevailed.

In 1999, the population size did not change. In 3 sites, 29 specimens in clusters of up to 200 cm in diameter, covering altogether 23 m^2, were noticed. The share of generative shoots ranged from 15 to 32%. Outside the premises of the reserve, the presence of 8 polycormic specimens covering in total 1.25 m^2 (20 to 60 cm in diameter) were noted. Vegetative shoots prevailed, amounting to 70-85% of the total shoot number.

In the recent years, the population size has drastically decreased. In November 2003, the presence of only 5 weak specimens in the reserve was confirmed. They grew only in one place located on the upper part of a hill.

In 2011, 3 small and evidently weak polycormic specimens were recorded. The maximal diameter of clusters ranged from 40 to 60 cm, while the total area covered was only 0.7 m^2. The number of shoots amounted to 298, from which only 53 were generative shoots (21,1% of all shoots). Outside the reserve, *Dianthus gratianopolitanus* has not been found.

3.3. Population reestablished in 2004-2011

In 2004, in the course of reestablishment process in the reserve, 52 cheddar pink clumps (all blooming specimens), were planted on the total area of 25 m^2 with spacing of 0.5 m, on a slope with SE exposure, ca. 15 m from the existing natural population. In 2011, 40 profusely flowering specimens were noted in the area of reestablishment. Altogether, 2284 shoots were counted

Fig. 1. Condition of the reestablished population of cheddar pink (photograph by K. Węglarski, June 2011)

in the above area – 1480 vegetative and 804 (35,3% of all shoots) generative ones.

4. Conclusions

Reestablishment of natural population of *Dianthus gratianopolitanus* in the reserve area provided good results – the transplanted specimens remain alive, show compact growth and good lifespan, and do not show any symptoms of diseases (Fig. 1).

Excessive shade resulting from the development of shrubs and large herbaceous plants, especially an invasive spread of *Padus serotina* and *Calamagrostis epigejos* (L.) Roth (Węglarski & Jańczyk-Węglarska 2000), can pose a threat to cheddar pink. In recent years, dead trees and gaps in monoculture pine forests have been observed. At present, black cherry is being removed from the whole reserve. Wild boars can also pose a threat to the population. The damage has already occurred, when they foraged for food in the part of reestablishment area.

Active protection can be one of the effective methods of rescuing this endangered species in *in situ* conditions. However, existing sites of cheddar pink should be further monitored in order to counteract unfavourable changes to the habitat in time. For the most endangered populations, the maintenance of preservative cultivation in controlled *ex situ* conditions is necessary. The seeds ought to be secured in a seed bank. In case of special care species, reestablishment and metaplantation of the endangered populations are the effective ways of environmental compensation, but it needs to be mentioned, that clearly defined procedures are lacking (Żółkoś *et al.* 2010).

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