

Rapid Communication**First spontaneous occurrence of *Centaurea macrocephala* (Asteraceae) in Poland**Grzegorz Łazarski^{1,*} and Artur Pliszko²¹Faculty of Exact and Natural Sciences, Siedlce University of Natural Sciences and Humanities, 08-110 Siedlce, Bolesław Prus 14, Poland²Institute of Botany, Faculty of Biology, Jagiellonian University, Gronostajowa 3, 30-387 Kraków, PolandAuthor e-mails: grzegorz.lazarski@gmail.com (GL), artur.pliszko@uj.edu.pl (AP)

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OPEN ACCESS**Abstract**

Centaurea macrocephala Muss. Puschk. ex Willd. (Asteraceae) is a perennial herb native to the Caucasus, Iran and Turkey. It has been introduced as an ornamental plant to Northern, Western and Central Europe, North America and New Zealand. In its primary range, the species occurs in glades of the upper montane zone, tall-herb vegetation and subalpine meadows. On secondary habitats, it occurs mainly in abandoned gardens, ruderal habitat, meadows and grassy clearings. In Poland, *C. macrocephala* is treated as a cultivated species and its naturalisation has not been confirmed so far. In this paper, we report a first spontaneous occurrence of the species in Poland. It was found in July 2018 in south Poland (Korzecko near Chęciny), growing on the secondary grassland near the bottom of an abandoned dolomite quarry. Most likely, the diaspores of *C. macrocephala* were introduced to the quarry with garden waste. The locality is mapped using the ATPOL cartogram method, photographic documentation of the species and phytosociological relevé documenting the floristic composition and plant cover of its habitat are provided. The species seems to be in an early stage of naturalisation; however, based on our own field observations we suggest that it should currently be classified as a casual alien species in Poland.

Key words: invasive alien species, alien ornamental plants, naturalisation, secondary range

Introduction

Horticulture is one of the main pathways of introduction of alien plant species (Reichard and White 2001; Dehnen-Schmutz et al. 2007; Hulme 2011; Richardson and Rejmánek 2011; Hulme et al. 2018). Seeds and seedlings of alien ornamental plants can be easily purchased in garden stores, nurseries, as well as online (Ööpik et al. 2013; Humair et al. 2015; Beaury et al. 2021). Unfortunately, many ornamental plants found to be invasive are still available for purchase via the horticulture trade (Monaco 2019; Olden et al. 2020; Beaury et al. 2021). The escape of alien ornamental plants from cultivation is a common phenomenon (Kowarik 2005; Dehnen-Schmutz et al. 2007). Ornamental plants can spontaneously escape from cultivation due to the dispersal of their diaspores by wind, water or animals (Kowarik 2005). Improper gardening practices, such as throwing away garden waste containing seeds or vegetative organs, can facilitate the

process of alien plants occurring outside of cultivation (Rusterholz et al. 2012; ERA 2020; Strgulc Krajšek et al. 2020). To prevent their naturalisation and invasion, alien ornamental plants should be introduced into cultivation very carefully, in compliance with all legal regulations that are binding on a regional, national and international scale (Hulme et al. 2018; Monaco 2019; Hulme 2020).

Centaurea macrocephala Muss. Puschk. ex Willd. is a perennial herb with a large taproot in the family Asteraceae native to the Caucasus, Iran and Turkey (Klokov et al. 1963; Wagenitz 1975). It grows up to 1.7 m and is characterised by its large capitula with yellow flowers (Keil and Ochsmann 2006). It was introduced as an ornamental plant to Northern, Western and Central Europe, North America and New Zealand (Keil and Ochsmann 2006; Randall 2017; CABI 2019). It is usually used as a cut flower in both fresh and dried flower arrangements (Williams 2013). According to CABI (2019), *C. macrocephala* is naturalised in Canada, the United States and the United Kingdom. Moreover, invasion of *C. macrocephala* was confirmed in some states of Canada (British Columbia) and the United States (Idaho and Washington) (Keil and Ochsmann 2006; WSNWCB 2008; PRRD 2017; CABI 2019). In its native range, *C. macrocephala* occurs in glades of the upper montane zone, tall-herb vegetation and subalpine meadows (Klokov et al. 1963; Wagenitz 1975). In North America, it occurs in abandoned gardens, meadows and grassy clearings, usually in loam and silt loam soils, at an elevation ranging from 400 to 2680 m a.s.l. (Keil and Ochsmann 2006; WSNWCB 2008). In Europe, it is usually found in abandoned gardens and ruderal habitats (Kaplan et al. 2018; Verloove 2018).

Centaurea macrocephala readily colonises disturbed areas with loamy, well drained soils with neutral pH and full sun. It is drought tolerant and well adapted to warm temperate and continental climate with dry summer (PRRD 2017; CABI 2019). It reproduces generatively by seeds and vegetatively by root crown division. A single capitulum can produce up to 200 fruit (cypselae). The mature fruits usually fall close to maternal plants but can be dispersed over long-distances by attachment to animal fur, vehicles and clothing. Moreover, the plant can be dispersed with dried flower arrangements and garden waste (WSNWCB 2008; PRRD 2017; CABI 2019; FVISS 2021). According to PRRD (2017) and FVISS (2021), *C. macrocephala* easily escapes from cultivation. In the state of Washington in the United States, it has been classified as a Class A noxious weed. It is very difficult to control once established and is a threat to natural areas, including subalpine meadows (WSNWCB 2008). It forms dense clumps of shoots causing displacement of native vegetation, reduces the availability of forage species for livestock and wild animals and, if abundant, limits human and animal mobility (WSNWCB 2008; PRRD 2017; FVISS 2021). The cultivation of *C. macrocephala* is prohibited in some regions of North America and prevention is a high priority for this plant (WSNWCB 2008; FVISS 2021). In Poland,

C. macrocephala is treated as a cultivated species and its naturalisation has not been confirmed so far (Gumieniak 2007; Tokarska-Guzik et al. 2012; Mirek et al. 2020). It is mainly used as an ornamental and honey plant (Wróblewska et al. 2016) and sometimes is recommended for sensory gardens (Pudelska et al. 2015). In this paper, we present a new spontaneous record of *C. macrocephala* in Poland.

Materials and methods

Identification of *C. macrocephala* was based on morphological features provided by Klokov et al. (1963) and Wagenitz (1975). A herbarium specimen was deposited in the Herbarium of the Institute of Botany of the Jagiellonian University in Kraków (KRA 0571596 – the herbarium acronym according to Index Herbariorum 2022). The distribution map of *C. macrocephala* in Poland was prepared using the ATPOL cartogram method (Zajac 1978). The determination of the floristic composition and plant cover of the habitat in which the plant grew was based on phytosociological relevé using the Braun-Blanquet method (Braun-Blanquet 1964). The nomenclature of the plant species followed Mirek et al. (2020). The status of *C. macrocephala* in the Polish flora was determined according to the criteria proposed by Pyšek et al. (2004).

Results and discussion

Centaurea macrocephala was found in July 2018 on secondary xerothermic grassland (Figure 1), which was formed near the bottom of the abandoned Korzecko dolomite quarry in Korzecko near Chęciny, Świętokrzyskie Mts., southern Poland (50.7984807°N; 20.4468126°E, 350 m a.s.l.). The new stand lies within the unit EE83 of the ATPOL cartogram grid (Figure 2). In 2018, three individuals of the species were found, and during the next observation in 2021, there were five. The main shoots of specimens usually formed several (2–4) offshoots (Figure 1). The dried remains of one individual were also present at the site. The species grew on the secondary grassland which developed on a rocky rendzinas on the gentle slope of an abandoned quarry near to its bottom. This phytocoenosis was mainly composed of thermophilic species typical of xerothermic grasslands of the *Festuco-Brometea* class (Relevé 1).

Relevé 1. Korzecko near Chęciny, 50.7984807°N; 20.4468126°E; date: 7.07.2021; area of relevé – 25 m²; eastern exposure; slope ~ 10°; coverage of herb layer (c) – 90%; coverage of moss layer (d) – 5%; c: *Arrhenatherum elatius* 2, *Artemisia campestris* subsp. *campestris* 2, *Festuca trachyphylla* 2, *Medicago falcata* 2, *Achillea collina* 1, *Acinos arvensis* 1, *Brachypodium pinnatum* 1, *Centaurea stoebe* 1, *Erigeron ramosus* 1, *Festuca arundinacea* 1, *Hypericum perforatum* 1, *Sanguisorba minor* s. str. 1, *Sedum album* 1, *Petrorhagia prolifera* 1, *Thymus kosteleckyanus* 1, *Aster amellus* +, *Berteroa incana* +, *Carlina vulgaris* +, ***Centaurea macrocephala*** +, *Chamaecytisus*



Figure 1. *Centaurea macrocephala* in Korzecko near Chęciny. A. Patch of secondary xerothermic grassland with one individual of the species. B. Capitulum bud. C. Blooming capitulum. Photographs by G. Łazarski; 7 July 2021.

ruthenicus +, *Daucus carota* +, *Dianthus deltoides* +, *Galium album* +, *Helianthemum nummularium* subsp. *obscurum* +, *Inula ensifolia* +, *Koeleria macrantha* +, *Lotus corniculatus* +, *Medicago lupulina* +, *Pimpinella saxifraga* +, *Potentilla arenaria* +, *Silene otites* +, *Silene vulgaris* +, *Trifolium arvense* +, *Vicia villosa* +.

In the quarry where the species was found, dolomite mining was terminated in 1976. Then, the extraction pit of the abandoned quarry was used as an illegal landfill by local residents. Along with household rubbish, plant material containing generative and vegetative diaspores from domestic gardens is often dumped there. Most likely, the diaspores of *C. macrocephala* were introduced to the quarry with the garden waste as evidenced in other studies (Rusterholz et al. 2012; ERA 2020; Strgulc Krajšek et al. 2020). The diaspores of *C. macrocephala* could be both vegetative parts (whole root systems or their parts) and generative parts (mature fruit). If the diaspores were thrown away along with a large amount of biomass (which is normally composted in horticulture), there is a good chance that they could

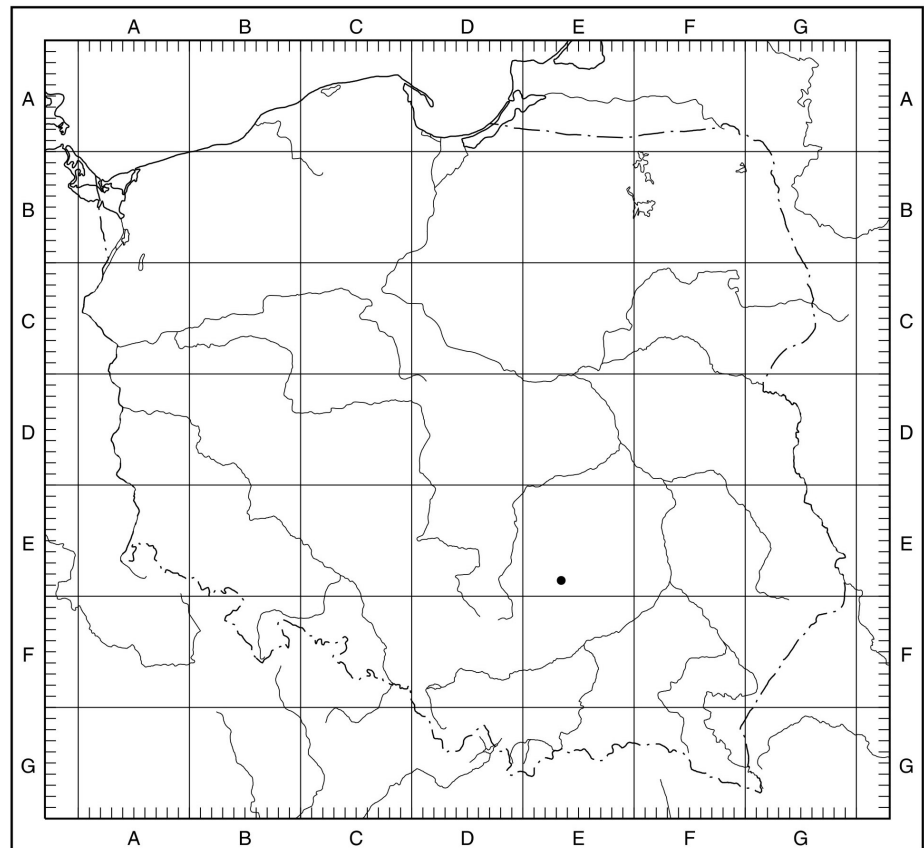


Figure 2. Locality of *Centaurea macrocephala* in Poland within the ATPOL cartogram grid.

overwinter in such a specific insulation material. The fruit of *C. macrocephala* could also have ended up in the quarry together with dried bouquets containing mature capitula, given that the plant is commonly used in dried flower arrangements (Williams 2013). It is also worth mentioning that the European Centre for Geological Education of the University of Warsaw was opened near the bottom of the Korzecko quarry in 2015. As a result of construction works carried out in 2014–2015, the bottom of the quarry was cleaned up and many disturbances were caused to the plant cover and soil. Importantly, no specimens of *C. macrocephala* have been planted near the Centre that could be viewed as a source of diaspores. It cannot be ruled out that the diaspores of the species were unintentionally delivered to the quarry along with the building material, soil or machines used in the construction site of the Centre. Most likely, the removal of woody and herbaceous plants and exposing the soil (rocky rendzinas) in the quarry, combined with climate warming clearly visible in the region (Łazarski 2020), created optimal habitat conditions for the naturalisation of *C. macrocephala* (Alston and Richardson 2006; Beans et al. 2012). It has been indicated that the species successfully colonises new areas and may be able to naturalise under warming climates (Haeuser et al. 2017). On the other hand, the tolerance of *C. macrocephala* to soil contamination appears to be low since it has been tested for soil recovery on sulphur mine wasteland fertilised with flotation lime and thickened municipal sludge (Klimont et al. 2013).

Many authors suggested that disused quarries are easily invaded by non-native plant species due to the availability of disturbed and usually warm habitats, with a low level of competition from other plants (Monty et al. 2019; Pitz et al. 2019; Bróz and Podgórska 2005). Nevertheless, a 10-year observation period is recommended to confirm the naturalisation of alien plant species (Pyšek et al. 2004); therefore, at present *C. macrocephala* should be classified as a casual alien species in Poland. Due to the high probability of its naturalisation, the plant should be removed from the quarry including both its aerial and underground parts. Moreover, new emergences of *C. macrocephala* should be monitored and controlled.

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Authors' contribution

GŁ: research conceptualization, methodology, investigation and data collection, writing original draft; AP: research conceptualization, methodology, writing the original draft.

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