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Occurrence of *Arnoseris minima* (L.) Schweigger et Koerte (Asteraceae) in Podlasie province (north-eastern Poland)

Anna Bomanowska[1]*, Wojciech Adamowski[2], Dan Wołkowycki[3]

[1] Department of Geobotany and Plant Ecology, Faculty of Biology and Environmental Protection, University of Łódź, Banacha 12/16, 90-237 Łódź, Poland

[2] Białowieża Geobotanical Station, Faculty of Biology, University of Warsaw, Sportowa 19, 17-230 Białowieża, Poland

[3] Department of Environmental Protection and Management, Bialystok University of Technology, Wiejska 45a, 15-351 Białystok, Poland

Abstract

New localities of *Arnoseris minima* (L.) Schweigger et Koerte (Asteraceae) in the Podlasie region (NE Poland) are presented. The current distribution of the species was established on the basis of the authors' floristic field studies, revised herbarium materials, published data, and unpublished sources. The collected data enabled us to revise the map of the species' distribution in the Podlasie region and supplement it with another new 17 localities. The previously established geographic range of species in Poland can now be moved by about 30 km eastwards and 50 km northwards. The identification of new locations of *A. minima* on the border of its continuous geographical range becomes important in the context of the declining number of localities of this species recently observed across almost the whole of Europe.

Keywords: arable weed; distribution; geographical range; Poland

Introduction

Arnoseris minima (L.) Schweigger et Koerte (Lamb's Succory; Asteraceae) is a small annual herb growing up to 35 cm. The leaves (5–10 cm in length) are all in a rosette at the base of the plant stem, they have a few small teeth around the edges, and are usually hairless. The inflorescence (7–11 mm in diameter) is a compound head of small, yellow florets. The heads are produced singly at the end of an erect stem. The numerous glabrous stems are very distinctive – inflated and hollow below the heads, and are sometimes simply-branched [1,2].

Arnoseris minima grows on poor, infertile sandy and sandy-loamy soils with low calcium carbonate content [3]. It is intolerant to saline soils, poorly reacts to fertilization, and is susceptible to ground frosts [2,4]. *Arnoseris minima* occurs on arable fields and field margins with poor soil crops, mainly in winter cereals, and less frequently in root crops. It is a characteristic species of *Arnoserido-Scleranthetum* (Edouard 1925) R. Tx. 1937 (*Sclerantho-Arnoseridetum minimae* R. Tx. 1937; *Stellarietea mediae* class), a subatlantic weed association occurring in rye crops and developing on acid dry soils [5,6]. It occasionally grows on sandy fallow ground, disturbed tracksides, and in gravel pits as well as in depressions between inland dunes [7–11].

* Corresponding author. Email: knopikaa@biol.uni.lodz.pl

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Arnoseris minima is native to Europe, with a subatlantic range [12,13]. The species is found in Portugal, north-western Spain, Great Britain, western France, Poland, the western margin of Belarus, and western Ukraine. In the north it is found in southern Scandinavia, while in the south in central Italy, Corsica, and Croatia [12,14,15]. *Arnoseris minima* has been accidentally introduced in the north-eastern parts of the USA and south-eastern Canada, but it has also been reported from south-eastern Australia and New Zealand [2,16,17].

In Poland, *A. minima* is found in lowlands, with large populations in the west and center of the country, but is much less numerous in north-eastern Poland where it reaches its continuous geographic range limit [14,18]. In the regions of Warmia and Masuria, north Podlasie and north-east Masovia, this species is found in very few dispersed localities [18–21].

A decline in the number of localities and population size of *A. minima* has been recently observed across almost the whole of Europe. Storkey et al. [22] reported that *A. mimima* is classified as a rare, endangered or extinct species in as many as 12 out of the 23 European countries. *Arnoseris minima* has the status of an extinct species in Great Britain [23], Hungary [24], Switzerland [2] and Slovakia [25], and is critically endangered in the Czech Republic [26,27]. In Germany the species is quite endangered with just a few, mostly small populations in fields or at field margins, and appears on many regional red lists, e.g., in Northeast Germany (Mecklenburg-Vorpommern), Lower Saxony and Bremen (Niedersachsen und Bremen), Bavaria, Brandenburg and Berlin, Schleswig-Holstein [2,4,28] as well as

in Baden-Württemberg and Saxony (F. Richter, personal communication, 2013). Additionally, it has been increasingly rarely reported from France, and is under protection in Upper Normandy and Aquitaine [29].

Because of the rapid decline of suitable habitats, the localities of the species are disappearing within a significant part of the geographical range. Therefore, the species has been included in an official document released by the Standing Committee of the Bern Convention [30].

In Poland, *A. minima* does not have the status of an endangered species on a national scale [31], but has been entered in regional red lists of segetal species for the regions of Opole [32], Upper Silesia [33], and Warmia and Masuria [20]. In the Podlasie province, it is a rather rare species and the general map of its distribution in Poland includes only nine localities from this region, in the southern and western part of the province [18]. There was no information about its distribution in other parts of the region (e.g., [34–47]).

In 2007, however, during floristic research we found two localities of *A. minima* on settlement clearings inside Białowieża Forest (Budy and Białowieża villages) and in 2008 another locality was found on the northern peripheral part of the forest (Porosłe village). A review of herbarium data from the collection of the Białowieża Geobotanical Station, University of Warsaw, and available literature on the flora of the region revealed other localities of *A. minima* in Podlasie, not included in the *Distribution atlas of vascular plants in Poland* [18].

The aim of this paper is to present a complete list of *Arnoseris minima* localities in the Podlasie province.

Material and methods

The list contains all the localities of *A. minima* noted to this day within the boundaries of the Podlasie province. The current distribution of this species was established on the basis of our own field investigations, revised herbarium records, published data, and unpublished sources. Field studies were carried out in 2007 and 2008, in agrocoenoses in the Białowieża Forest area. During the investigations, phytosociological relevés were made according to the Braun-Blanquet method [48].

The distribution of species localities was mapped using the ATPOL grid based on 2 × 2 km cartogram units [49]. The list of localities was arranged in the same system, and for each site the following information was given: number of the ATPOL square, locality, habitat (if known), year of finding and/or publication where the locality was described for the first time, data source with the author's name. Most new unpublished localities of *A. minima* are documented by collected specimens deposited in the Herbarium of the Białowieża Geobotanical Station (BSG). The nomenclature of the species follows Mirek et al. [50].

Results

The gathered data enabled us to revise the cartogram of *A. minima* distribution in the Podlasie region and supplement it with another 17 localities, including seven from the area of Białowieża Forest and its south-western foreland (Fig. 1, Tab. 1).

Most of the previously reported localities [18] were noted in the 1960s, and generally it was difficult to describe the habitats in which *A. minima* and associated plants grew (Tab. 1). However, the localities identified based on literature data, more recent herbarium collections, and those found in the early 21st century are mainly associated with habitats of cereal crops. In two cases *A. minima* was found in non-agricultural habitats: psammophilous grassland and fresh pine forest (Tab. 1).

The largest population of several thousand individuals of *A. minima* (author's personal observation, 2008), was found in Porosłe village. Here, *A. minima* reached over 10% cover in a winter rye crop and was associated with 15 weed species, i.e., *Apera spica-venti* and *Holcus mollis* being the most numerous. Other plants identified were *Achillea millefolium*, *Bidens tripartita*, *Carex hirta*, *Equisetum arvense*, *Fallopia convolvulus*, *Galeopsis bifida*, *G. ladanum*, *Polygonum hydropiper*, *Pteridium aquilinum*, *Rhinanthus serotinus*, *Rumex acetosella*, *Setaria pumila*, and *Spergula arvensis*.

Arnoseris minima was also numerous on one-year fallow (10% cover), where it was found together with 13 other species: *Apera spica-venti*, *Chenopodium album*, *Digitaria ischaemum*, *Elymus repens*, *Fallopia convolvulus*, *Galeopsis bifida*, *G. ladanum*, *Holcus mollis*, *Phragmites australis*, *Polygonum lapathifolium* subsp. *lapathifolium*, *Rumex acetosella*, *Setaria pumila*, and *Spergula arvensis*.

The locality of *A. minima* in a spring wheat crop on the Białowieża Clearing comprised several hundred individuals (author's personal observation, 2007). Apart from *A. minima*, 19 other weed species were identified: *Anagallis arvensis*, *Anthriscus sylvestris*, *Apera spica-venti*, *Avena fatua*, *Cirsium arvense*, *Convolvulus arvensis*, *Conyza canadensis*, *Equisetum arvense*, *Lotus corniculatus*, *Matricaria maritima* subsp. *inodora*, *Mentha arvensis*, *Plantago intermedia*, *Polygonum hydropiper*, *Prunella vulgaris*, *Setaria pumila*, *Sonchus arvensis*, *Spergula arvensis*, *Veronica persica*, and *Viola arvensis*.

A significantly lower number of individuals (under 100; author's personal observation, 2007) was found in the Budy village locality in a stubble field where, apart from *A. minima*, only three weed species were identified: *Polygonum hydropiper*, *P. persicaria*, and *Setaria pumila*. Additionally, in the locality in Pogorzałki in a spring oat crop, only single individuals of *A. minima* were found (K. Snarska – personal communication, 2009).

Discussion

With new localities of *A. minima* identified on the eastern margins of its geographic range and by revising the herbarium materials and literature data, the previously established geographic range of *A. minima* in Poland can now be moved by about 30 km eastwards and 50 km northwards.

The obtained results are important in the context of the increasing threat and the declining number of localities of this species in Europe (e.g., [22,51]). The development of

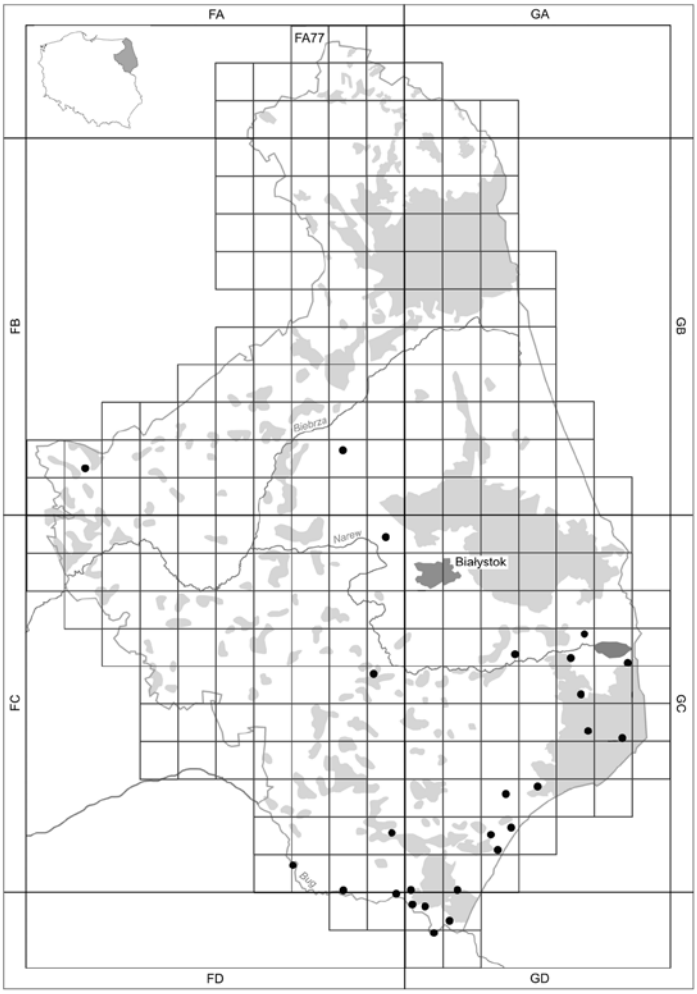

Fig. 1 Distribution of *Arnoseris minima* in the Podlasie province (NE Poland). The borders of the province, forests, the main rivers, and the ATPOL grid (the square signature is given in one plot only) are shown on the map.

modern large-scale agriculture and intensified methods of soil preparation and crop cultivation have negative effects on the occurrence of *A. minima* in segetal habitats (e.g., cereal crops). The major limiting factors include soil eutrophication caused by overuse of organic fertilizers and the supply of large doses of nitrogen fertilizers as well as the cessation of farming on the poorest soils, the most suitable habitats for *A. minima* [51,52]. Dense sowing and the introduction of cereals with long and rigid stems have also negative effects on the occurrence of *A. minima*. Due to its rosette structure and biology of growth, the species is unable to compete with strong-growth cereals [51]. Indirectly, the populations of *A. minima* are limited by the removal of balks or by the planting of trees on the balks, leading to the decline of linear structures in the landscape. Linear structures are potential refuge areas for *A. minima* [2].

In north Podlasie the populations of *A. minima* are exposed to the same risk factors as those currently existing and common within the entire geographic range. The acreage of potential habitats has been reduced considerably as a result of the relatively rapid abandonment of farming on the poorest acid and sandy soils in the past 30 years [53,54]. Most likely, some localities of *A. minima* were also destroyed after the filling of the artificial water reservoir at Siemianówka, located on the northern periphery of Białowieża Forest.

Apart from the availability of habitat, climate and the long-term pattern of weather, may be a major factor limiting the occurrence *A. minima* in the region. However, it is still debatable whether the increase in the number of identified localities and displacement of the previously established range limit in Europe in a north-easterly direction can be linked with climate changes, manifested by higher temperature and precipitation in the past decades. It may simply result from more detailed field research on the distribution of species and not be interpreted as the displacement of the range limit.

The identification of new localities of *A. minima* also stimulates the need for additional studies on the occurrence of the *Arnoserido-Scleranthetum* association in the Północnopodlaska Lowland, whose low-diversified patches on the north-east margin has so far been reported only from the Podlasie-Masovia border (Podlasie Gorge of the Bug River) [55] and from the present Warmińsko-Mazurskie province (Olsztyn Lake District, Masuria Lake District, and Kurpiowska Plain) [5,56].

Tab. 1 List of current localities of *Arnoseris minima* in the Podlasie province.

ATPOL plot	Locality	Habitat	Source/author
Localities included in *Distribution atlas of vascular plants in Poland* (ATPOL) [18]			
FB 8132	Popiołki	No data	A.W. Sokołowski unpubl. 1992 after Zając and Zając [18]
FB 88??	N Mońki	No data	A.W. Sokołowski unpubl. 1969 after Zając and Zając [18]
FC 8922	Żurobice	No data	A.W. Sokołowski unpubl. 1971 after Zając and Zając [18]
FC 4910	Pietkowo	No data	A.W. Sokołowski unpubl. 1970 after Zając and Zając [18]
GC 3234	Trześcianka	No data	A.W. Sokołowski unpubl. 1968 after Zając and Zając [18]
GC 8221	2 km SW Czeremcha-Osada	No data	[57]
GC 8242	2 km NE Zubacze	One-year fallow	[58]
GC 9141	2 km SW Wilanowo/Siemichocze	One-year fallow	[58]
GD 002?	Mielnik	No data	D. Fijałkowski unpubl. 1976 after Zając and Zając [18]; compare Marciniuk et al. [59]
New localities, not included in *Distribution atlas of vascular plants in Poland* (ATPOL) [18]			
FC 0922	Pogorzałki	oat	K. Snarska unpubl. 2009
FC 9710	NE Mołożew	sandy field	[60]
FC 984?	Zajęczniki	cereal crops, sandy fallow	[61]
FD 0904	Maćkowicze	winter rye	[55]
GC 3403	Juszkowy Gród	pine forest	leg. D. & W. Mieńko 1981, Herbarium BSG
GC 3441	Porosłe	winter rye	leg. W. Adamowski 1991, 1993 Herbarium BSG
		winter rye	leg. A. Bomanowska, W. Adamowski 2008, Herbarium BSG
		one-year fallow	leg. A. Bomanowska, W. Adamowski 2008, Herbarium BSG
GC 3544	Babia Góra	psammophytic grassland	leg. W. Adamowski 1991 Herbarium BSG
GC 4433	Skupowo	one-year fallow	leg. W. Adamowski 1991, Herbarium BSG
GC 5434	Budy	stubble	A. Bomanowska unpubl. 2007
GC 5544	Białowieża	spring wheat	A. Bomanowska unpubl. 2007
GC 7312	Wiluki	one-year fallow	leg. W. Adamowski 1992, Herbarium BSG
GC 7213	Jelonka	winter rye	leg. J.B. Faliński 1977, Herbarium BSG; compare Faliński et al. [53]
GC 8214	Wólka Terechowska	one-year fallow	leg. W. Adamowski 1993, Herbarium BSG
GC 904?	Moszczona Królewska	cereal crops, sandy fallow	[61]
GD 0010	Osłowo	winter rye	[55]
		stubble	[62]
		cereal crops, sandy fallow	[61]
GD 0130	Sutno	stubble	[61]
GD 1003	Wajków	winter rye	[55]

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Authors' contributions

The following declarations about authors' contributions to the research have been made: field research: AB, WA; data and archival materials analyses: AB, WA, DW; map preparation: DW; writing the manuscript: AB, WA; final editing: AB, WA, DW.

Competing interests

No competing interests have been declared.

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Występowanie *Arnoseris minima* (L.) Schweigger et Koerte (Asteraceae) w województwie podlaskim (północno-wschodnia Polska)

Streszczenie

Arnoseris minima – chłodek drobny (Asteraceae), to roślina roczna, związana z silnie zakwaszonymi i pozbawionymi węglanu wapnia siedliskami segetalnymi. Jest gatunkiem charakterystycznym subatlantyckiego zespołu *Arnoserido-Scleranthetum* (Edouard 1925) R. Tx. 1937 (*Scleranthо-Arnoseridetum minimae* R. Tx. 1937), występującego w zasiewach zbóż ozimych na lekkich glebach. *Arnoseris minima* osiąga w Polsce północno-wschodniej kres zasięgu i wg *Atlasu rozmieszczenia roślin naczyniowych w Polsce* (ATPOL) udokumentowano tylko dziewięć stanowisk tego gatunku w województwie podlaskim, skupionych w południowej i zachodniej części regionu. Brak było informacji o występowaniu *A.minima* w innych częściach Podlasia. Własne badania autorów oraz informacje uzyskane od osób zajmujących się zachwaszczeniem pól uprawnych, a także przegląd materiałów archiwalnych z zielnika Białowieskiej Stacji Geobotanicznej Uniwersytetu Warszawskiego i literatury florystycznej z regionu, umożliwiły rewizję kartogramu rozmieszczenia gatunku na Podlasiu i uzupełnienie go o kolejne 17 stanowisk. Nowe stanowiska zlokalizowane są głównie w zasiewach zbóż, a co najmniej jedno z nich odznacza się dużą liczebnością populacji, sięgającą kilku tysięcy osobników. Zebrane dane przesuwają rozpoznany zasięg *A. minima* na badanym terenie o około 30 km w kierunku wschodnim i 50 km w kierunku północnym.