Common locality of *Asplenium ruta-muraria* and *Asplenium trichomanes* (*Aspleniaceae*) in north-eastern Poland

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Abstract: The article presents a common locality of *Asplenium ruta-muraria* and *Asplenium trichomanes* (*Aspleniaceae*) in north-eastern Poland. *Asplenium ruta-muraria* and *Asplenium trichomanes* are small ferns occurring on limestone, especially in southern Poland. In north-eastern Poland they are very rare species, found mainly on old walls and stone fences. Common locality of *Asplenium ruta-muraria* and *Asplenium trichomanes* was again subjected to a floristic inventory in September of 2020 in Ciechanowiec (Podlaskie Province). The populations consist of about **87** individuals of *Asplenium ruta-muraria* and **1001** individuals of *Asplenium trichomanes*, both growing on stone fences around old nineteenth-century cemetery in Ciechanowiec (**ATPOL plot FC66**). These locality isn't threatened now, but it is suggested to remove shrub cover (especially *Robinia pseudoacacia* and *Urtica dioica*) from those parts of the walls in order to maintain the local populations of *Asplenium ruta-muraria* and *Asplenium trichomanes*.

Key words: ferns, distribution, rare species, vascular plants, *Asplenium ruta-muraria*, *Asplenium trichomanes*

1. Introduction

Asplenium L. is a group of over 700 terrestrial and epiphytic fern species within the *Aspleniaceae* family (Smith et al., 2006). Wagner at al. (1993) noted, that a satisfactory taxonomic division of the genus *Asplenium* into subgenera or genera (e.g. *Phyllitis* J. Hill, *Ceterach* Willd., *Pleurosorus* Fée) is not possible because of the absence of any significant gaps. Ekrt & Štech (2008) indicated, that distribution and the morphological variation of *Asplenium* taxa are insufficiently known in Central and Eastern Europe, as they are often not adopted in local floras or checklists. Thus, the results of the research presented in this article will allow to supplement the data on the number and location of *Asplenium* in the Północnopodlaska Lowland area in Poland (Central Europe).

Currently, there are eight species of *Asplenium* in Poland, as well as one hybrid taxon (Kołos & Wołkowycki, 2018). Among them, there are four species (*Asplenium adulterinum*, *Asplenium cuneifolium*, *Asplenium adiantum-nigrum*, and *Asplenium septentrionale*) which are legally protected (Rozporządzenie Ministra Środowiska z dnia…, 2014). According to Kołos and Wołkowycki (2018), these ferns are a frequent element of the native flora in southern Poland and are rare in the lowlands. In the area of north-eastern Poland, the number of locations of the taxa of the genus *Asplenium* L. is very small, because the *Asplenium ruta-muraria* is scattered and more often than *Asplenium trichomanes* (Kołos & Wołkowycki, 2018). It is an endangered species in the Kaliningrad District of Russia (Gubareva, 2010).
The aim of this study is to supplement the data on the number and distribution of *Asplenium ruta-muraria* and *Asplenium trichomanes* in the region of the Północnopodlaska Lowland (north-eastern part of Poland).

2. Characteristics of *Asplenium ruta-muraria* and *Asplenium trichomanes*

***Asplenium ruta-muraria* L.** is a small fern, with two or five-fold feathery leaves, 5-15 cm long, with triangular ovoid or elongated blades, mounted on long green leaf petioles (Mowszowicz, 1979). It is a characteristic species for crevice communities and calcareous substrates of the order *Potentilletalia caulescentis* JENNY 1926 and the *Asplenitum trichomano-rutae-murariae* association (KUHN 1937) R.TX. 1937 (Matuszkiewicz, 2012). The closest to Północnopodlaska Lowland locality of *Asplenium ruta-muraria* - is situated in the Lublin Upland (Fijałkowski, 1994-1995). It is found throughout Europe, Asia, North America and the northern coasts of Africa (Fig. 1). In Poland, it is most often found in southern and south-western Poland: in Lower and Upper Silesia, the Krakowsko-Częstochowska Upland, Podhale, Lubuska Land and the Szczecińskie Lakeland. It is less numerous in the area of Wielkopolska, Niecka Nidziańska and Roztocze (Pindel & Pindel, 2007). The *Asplenium ruta-muraria* locations from the A-4 motorway lane, in the Góra Świętej Anny Landscape Park, in the Opolskie Voivodeship (Spałek & Mleczko-Król, 2014) and from Kamieniec in the Dynowskie Foothills (Wójcik & Ziaja, 2015) were also described. In the area of the Północnopodlaska Lowland, *Asplenium ruta-muraria* was recorded only once about 20 years ago, during research on the flora of ruderal habitats by Wołkowycki (2000), on the wall of the Ciechanowiec cemetery, accompanied by *Asplenium trichomanes* and mosses.

***Asplenium trichomanes* L.** – is a small fern with characteristic feathery leaves 5-30 cm long, with reddish-brown narrow axes, on which there are dark green leaves with a notched edge. This species is characterized by a wide geographical range (Fig. 2); found throughout Europe (Meusel et al., 1965; Hultén & Fries, 1986). In some regions of Eastern Europe – Lithuania, Belarus and Estonia - this taxon is considered as rare (Obelevičius, 1999; Rašomavičius, 2007; Tupčiauskaite, 2007; Parfenov, 2009; Tulev, 2009). *Asplenium trichomanes* is also found in central and eastern Asia, the northwest of Africa, North America, Australia and New Zealand (Moran, 1982). The analysis of the literature confirms that in Poland the greatest number of this species is found in the Carpathians, the Krakowsko-Częstochowska Upland and Roztocze (Zając & Zając, 2001). On the other hand, within northern and north-western Poland, it is considered as a dying-out species: in Wielkopolska and Western Pomerania (Żukowski & Jackowiak, 1995; Buliński, 2000; Jackowiak et al., 2007), in Gdańsk Pomerania (Markowski & Buliński, 2004) and the Zachodniosuwalskie Lakeland (Pliszko, 2017). *Asplenium trichomanes* was placed on the "red lists" of the Opolskie Voivodeship (**category – LC)** (Nowak et al., 2008) and of plants of the South Podlasie Lowland (**category – DD)** (Głowacki et al., 2003). In the Północnopodlaska Lowland *Asplenium trichomanes* is very rarely found. In this region this species was known only from six locations: from Ciechanowiec and Suraż (Wołkowycki, 2000, 2017), Osowiec-Twierdzy in the Biebrza National Park (Rygasiewicz, 1997; Werpachowski, 2000, 2005), and from Suwałki Region (Pliszko, 2010, 2014, 2017; Romański, 2012), as well as from the vicinity of the villages of Czyże, Malesze and Szczyty-Dzięciołowo (Kołos & Wołkowycki, 2018). *Asplenium trichomanes* in the above-mentioned research stands colonizes only substrates of anthropogenic origin: stone cemetery fences (covered on almost all sides with moss cushions, with numerous crevices filled with organic sediments), ruins of concrete fortifications, or piled field stones.

3. Methods

Field study of the common locality of *Asplenium ruta-muraria* and *Asplenium trichomanes* was conducted in September of 2020 in Ciechanowiec (Podlaskie Province). The phytosociological research consisted in counting all individuals of both species of ferns growing on the wall of the cemetery in Ciechanowiec. Due to the specificity of the research

site (cemetery), no complete geobotanical research and descriptions were performed. It was limited to determining the quantity and sociability of both species of ferns and taking into account invasive species. Based on the obtained numerical data, maps of the distribution of *Asplenium ruta-muraria* and *Asplenium trichomanes* along the cemetery wall were prepared (Fig. 3 and 4). Figure 3 and 4 were made using Power Point program. Sometimes individuals of *Asplenium ruta-muraria* and *Asplenium trichomanes* formed groups. In the study area both fern species represent the phytisociological association of *Asplenitum trichomano-rutae-murariae* (KUHN 1937) R.TX. 1937, order - *Potentilletalia caulescentis* BR.- BL. in BR.- BL. et JENNY 1926 and class: *Asplenietea rupestrian* BR.- BL. 1934 in MEIER et BR.- BL. 1934. The classification of plant communities with the participation of dominant species (*Asplenium ruta-muraria* and *Asplenium trichomanes*) in the study area - was made after Matuszkiewicz (2012). The names of ferns were adopted after Mirek et al. (2002). The sociability and quantity of the *Asplenium ruta-muraria* and *Asplenium trichomanes* were given using the Braun-Blanquet phytosociological scale (Braun-Blanquet 1964). The maps of the distribution of *Asplenium ruta-muraria* and *Asplenium trichomanes* were given in the squares of the ATPOL network after Zając (1978). Figure 9 showing the location of all current sites of *Asplenium ruta-muraria* and *Asplenium trichomanes* in the North Podlasie Lowland was made in the ATPOL program. The distribution maps of invasive species R*obinia pseudoacacia* and *Urtica dioica*, threatening the development of the populations of *Asplenium ruta-muraria* and *Asplenium trichomanes*, were also prepared (Fig. 5). Additionally, the article presents maps of the geographical ranges of both ferns (Fig. 1 and 2) and the scope of renovation of the walls of the cemetery in Ciechanowiec (Fig. 6).

4. Study area

Recently, a common locality of the occurrence of two rare species of ferns: *Asplenium ruta-muraria* and *Asplenium trichomanes* in Ciechanowiec, in the Północnopodlaska Lowland (north-eastern Poland) was subjected to a re-inventory of floristics (Fig. 7, 8 and 9).

Ciechanowiec is a small town in Podlasie (52°41'10"N 22°29'30"E) with an area of 26.01 km^2, with 5 thousand inhabitants (Strategia Rozwoju Gminy…, 2008). It received city rights in 1429 from the hands of the Duke of Mazovia, Janusz I the Great (Tomaszewski, 2008). Ciechanowiec is located in the Mazowiecko-Podlaska Lowland, on the border of two mesoregions: Wysoczyzna Siedlecka and Bielska (Kondracki 2013). The most numerous

plant communities in this area are: riverside willow and poplar riparian forests, ash-alder lowland riparian forests, continental mixed pine and oak forests, continental pine forest, and subcontinental oak-hornbeam forest (Studium Uwarunkowań…, 2017). Ciechanowiec is also characterized by a great diversity of cultural heritage. There are historical urban layouts, sacred architecture buildings (church, churches, synagogue), cemeteries of various denominations, defensive structures (remains of the castle complex) and archaeological monuments (Kiercul 2020).

5. Results

In September of 2020, significant populations of two ferns *Asplenium ruta-muraria* and *Asplenium trichomanes* from *Asplenitum trichomano-rutae-murariae* association were found on the walls of the Ciechanowiec cemetery from 1842, built of rough stones (**ATPOL FC66 network square**). This wall are abundantly covered by mosses and epibryophytic lichen species: *Lepraria elobata*, *Lepraria finkii*, *Lepraria incana* and *Peltigera didactyla* (see: Zabuska, 2005, Kiercul, 2020). On this locality, on the cemetery's wall stretching from the north to the south, **1001** individuals of *Asplenium trichomanes* (Fig. 4) and **87** individuals of *Asplenium ruta-muraria* were recorded (Fig. 3).

According to the Braun-Blanquet phytosociological scale, the sociability of the *Asplenium ruta-muraria* species in the study area was described as a value of 2 (the species grows in groups or clumps), its quantity as a value of 1 (the species covers < 5% of the area but the number of its specimens is large 5-50). According to the Braun-Blanquet phytosociological scale, the sociability of the *Asplenium trichomanes* species in the study area was described as a value of 2 (the species grows in groups or clumps), its quantity as a value of 2 (the species covers 5-25% of the area, and the number of its individuals is large).

6. Summary and Conclusions

In Podlasie the populations of *Asplenium trichomanes*, especially *Asplenium ruta-muraria*, are isolated and dispersed. Both ferns are characterized by a significant reproductive and dispersive potential, which is associated with the production by both of these species of large amounts of light spores, freely lifted for longer distances by the wind (Edgington, 2007; Lashin, 2012). Therefore, this very rare occurrence of both ferns in the area of north-eastern Poland strongly depends on other conditions, for example like: the prevailing climate - with

subboreal and subcontinental properties and low rainfall (Kołos & Wołkowycki, 2018), as well as insufficient availability of attractive habitats. There are no natural rock formations in the study area, and the anthropogenic substrates corresponding to the preferences of *Asplenium* sp. (old cemetery walls and stone fences) are few. The most serious threat to the identified populations of *Asplenium ruta-muraria* and *Asplenium trichomanes* in north-eastern Poland is the restoration of old walls and fences. Bremer (2004) also points another factors such as: negative impact of interspecies competition - mainly from grasses and some perennials (e.g. nettles, raspberries), very low temperatures in cold winters and too much sun exposure. The old stone wall around the Ciechanowiec cemetery was renovated, however, depending on the exposure, it was uneven. As a result, part of the *Asplenium trichomanes* population was significantly eliminated (see: Wołkowycki, 2000). The financial possibilities of the parish in Ciechanowiec mean that no renovation of the cemetery fence is planned in the near future. This situation, as well as the cyclical cleaning of the cemetery walls of unnecessary bushes (especially the expansive *Robinia pseudoacacia* and *Urtica dioica*) should contribute to the reconstruction of the *Asplenium trichomanes* population and further colonization by *Asplenium ruta-muraria*.

Robinia pseduacacia is an invasive plant belonging to the *Fabaceae* family. It is a plant of ruderal communities. Low habitat requirements and the formation of root suckers facilitate the expansion of juveniles of this plant. *Robinia pseudoacacia* easily wins interspecific competition with native flora for available habitat resources. In such a situation, the control of this plant by cutting should be carried out systematically, at short intervals, until its viability is completely exhausted (Dajdok & Śliwiński, 2009). The entire process takes at least 4 years.

Urtica dioica is a similarly expansive plant, belonging to the *Urticaceae* family. This plant grows on damp forests and thickets, and very often as a synanthropic species - fertile ruderal habitats. *Urtica dioica* spreads both through seeds and vegetatively - mainly via underground rhizomes. After some time, individual specimens can form extensive clones, consisting of many above-ground shoots (Carey, 1995). In the classification of plant communities in Central Europe, it is a species characteristic of Cl. *Artemisietea vulgaris* and a distinguishing species for Ass. *Poo-Arabidetum* (Matuszkiewicz, 2012). The best way to eliminate *Urtica dioica* is to remove this plant along with its rhizomes. While loosening the soil, remove the nettle rhizomes from the ground and destroy the seedlings germinating in spring and autumn. *Urtica dioica* does not tolerate regular shaking and digging of the soil at the depth of the rhizomes - it tolerates fragmentation very poorly. This plant does not regenerate in small

sections (Bond et al., 2007). Both plants - *Robinia pseudoacacia* and *Urtica dioica*, often occur in soils rich in nitrogen compounds, therefore they occur together in large amounts in the study area. Cleaning the walls of the cemetery in Ciechanowiec, using mechanical methods, must be a systematic and long-term process. This is the only way to preserve the valuable populations of both rare ferns in the Północnopodlaska Lowland area - *Asplenium ruta-muraria* and *Asplenium trichomanes,* which develop on this site.

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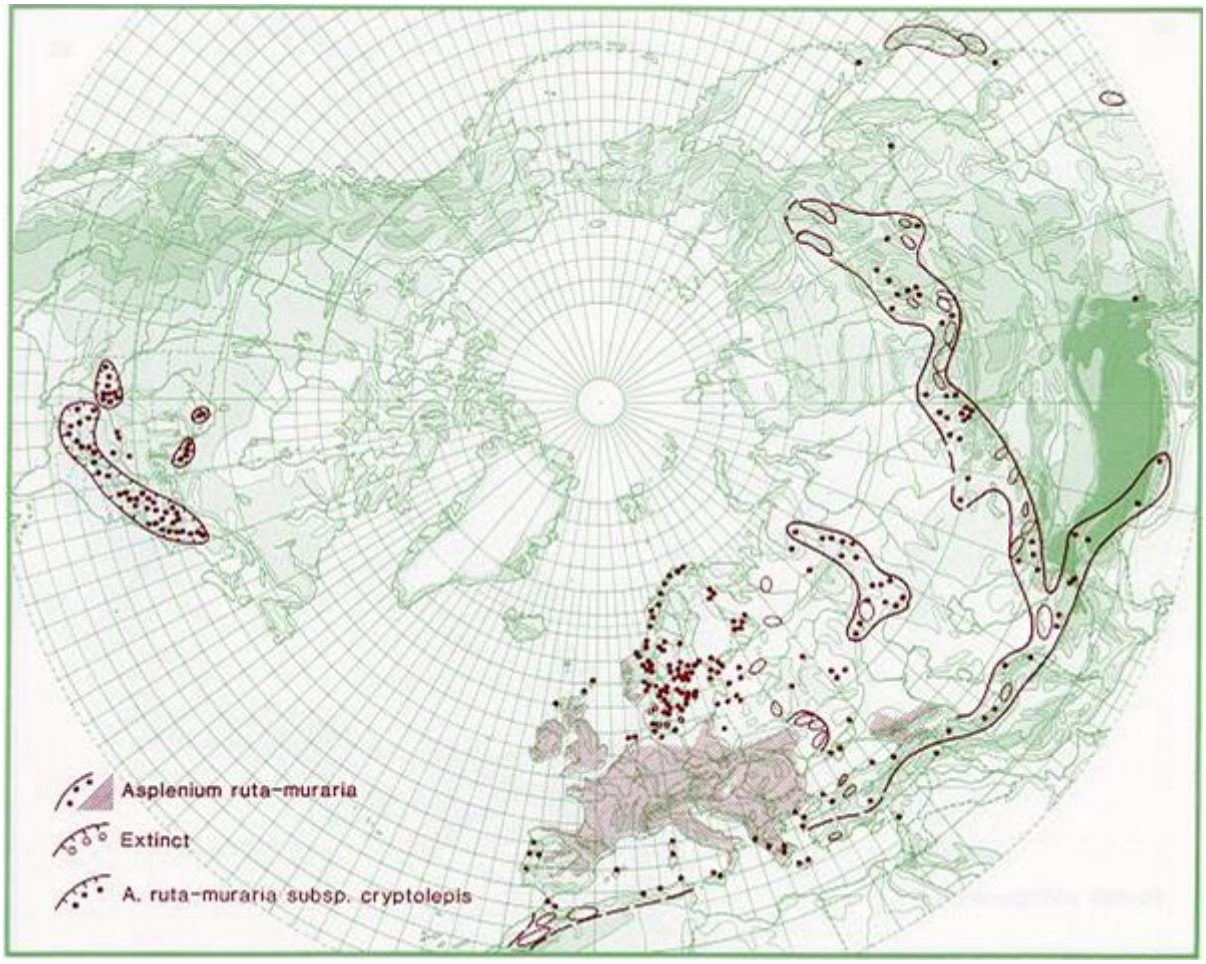

Figure 1. Geographical range *Asplenium ruta-muraria* (after: Den virtuella floran)

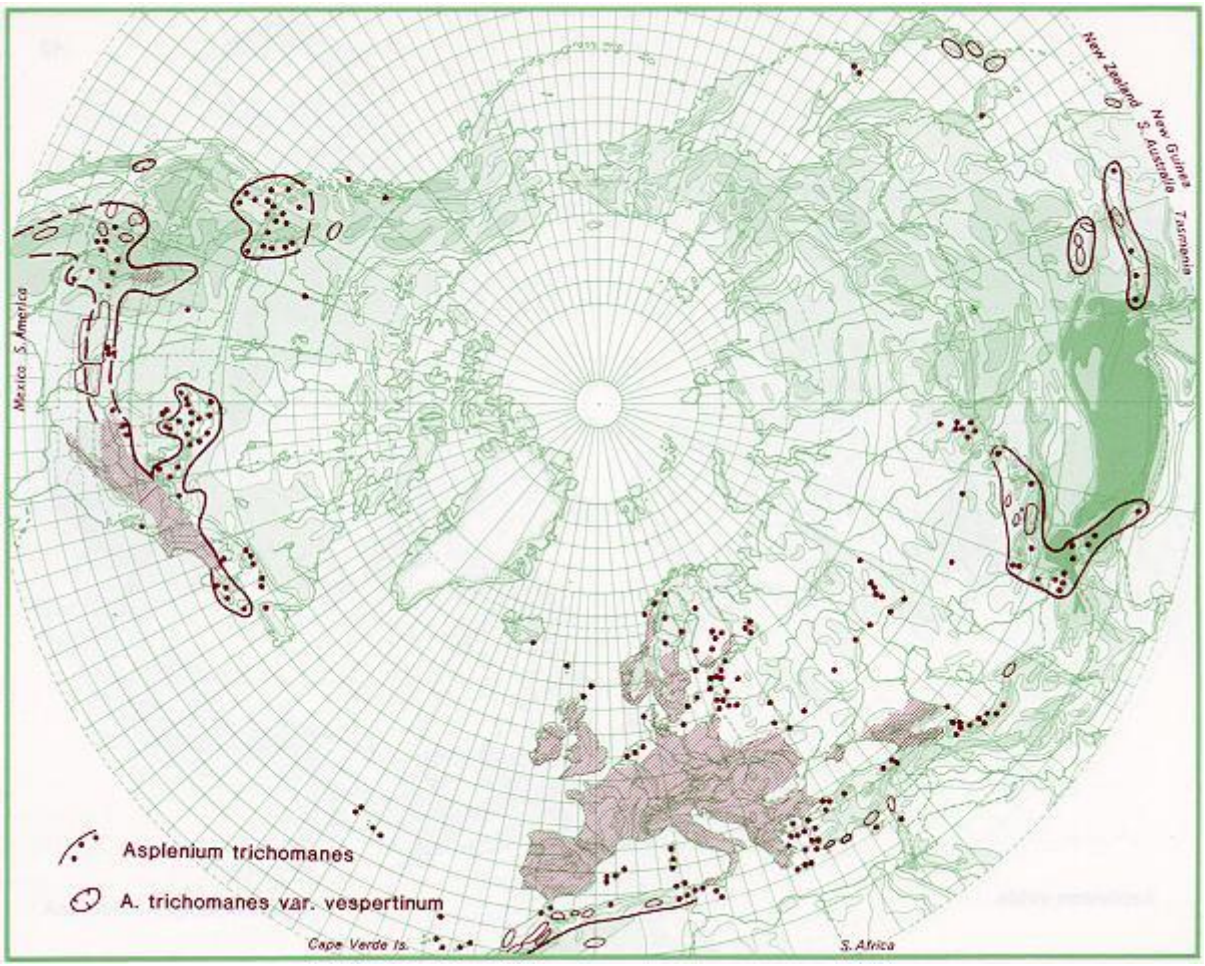

Figure 2. Geographical range *Asplenium trichomanes* (after: Den virtuella floran)

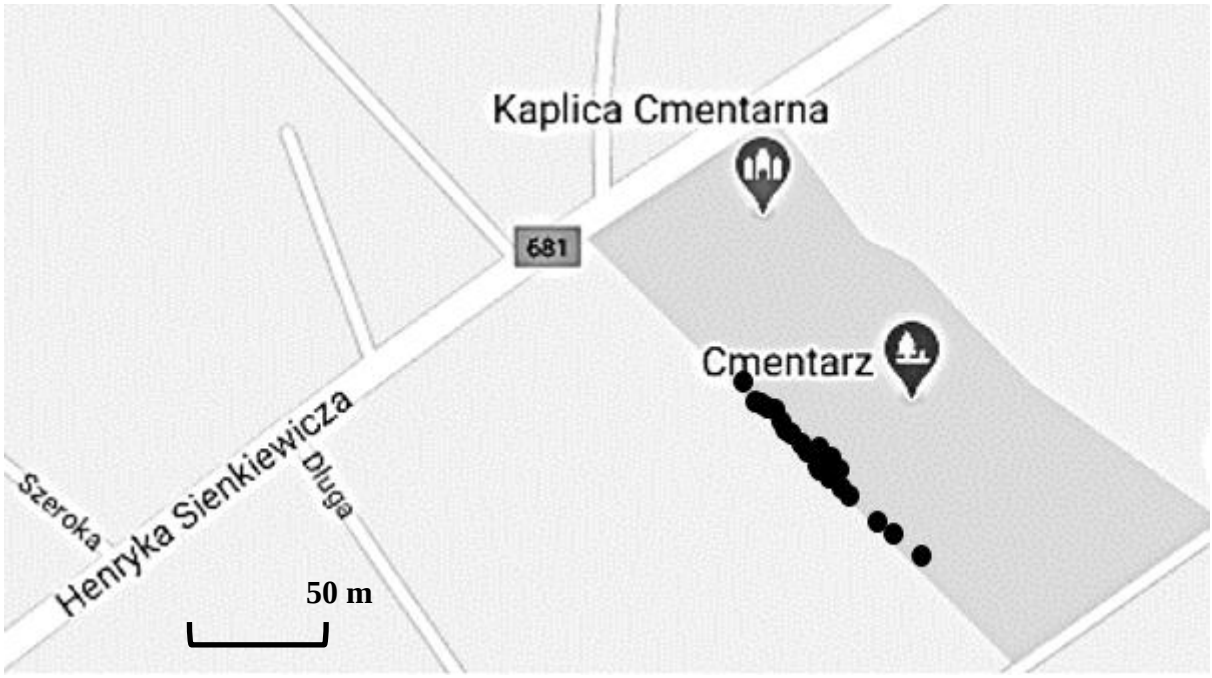

Figure 3. Location of the exposition of the cemetery wall overgrown by *Asplenium ruta-muraria* Ciechanowiec, Sienkiewicza Street (by Sylwia Kiercul)
* groups of individuals of *Asplenium ruta-muraria* are marked with a black filled circle

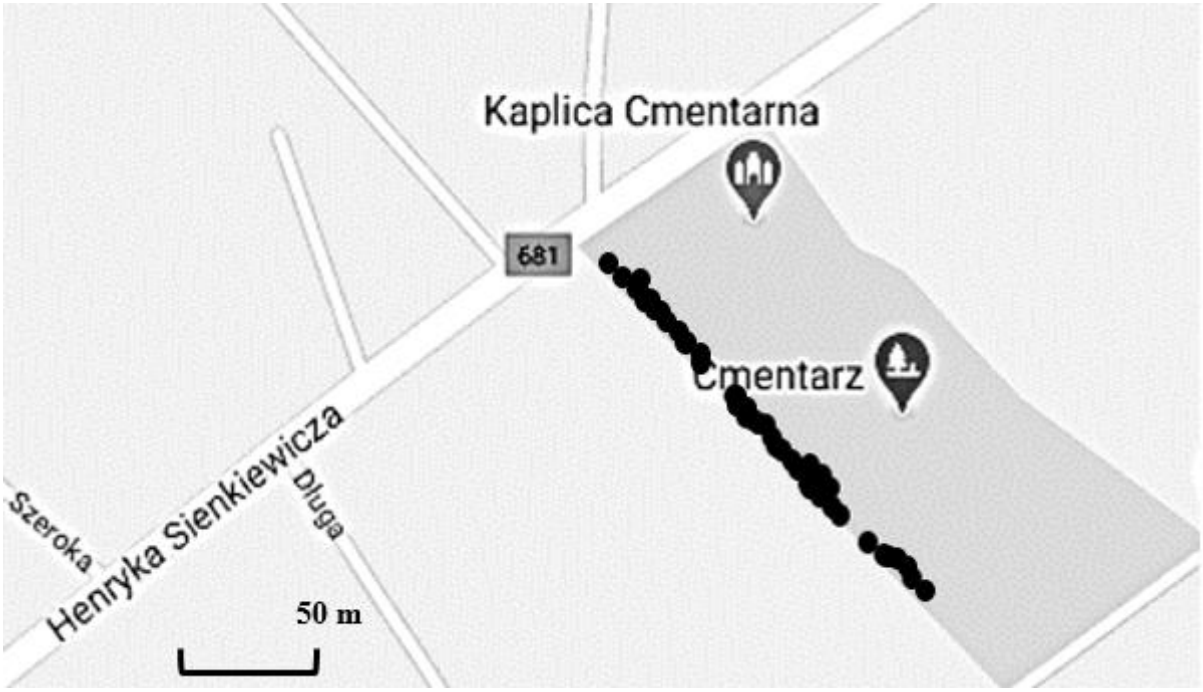

Figure 4. Location of the exposition of the cemetery wall overgrown by *Asplenium trichomanes* Ciechanowiec, Sienkiewicza Street (by Sylwia Kiercul)
* groups of individuals of *Asplenium trichomanes* are marked with a black filled circle

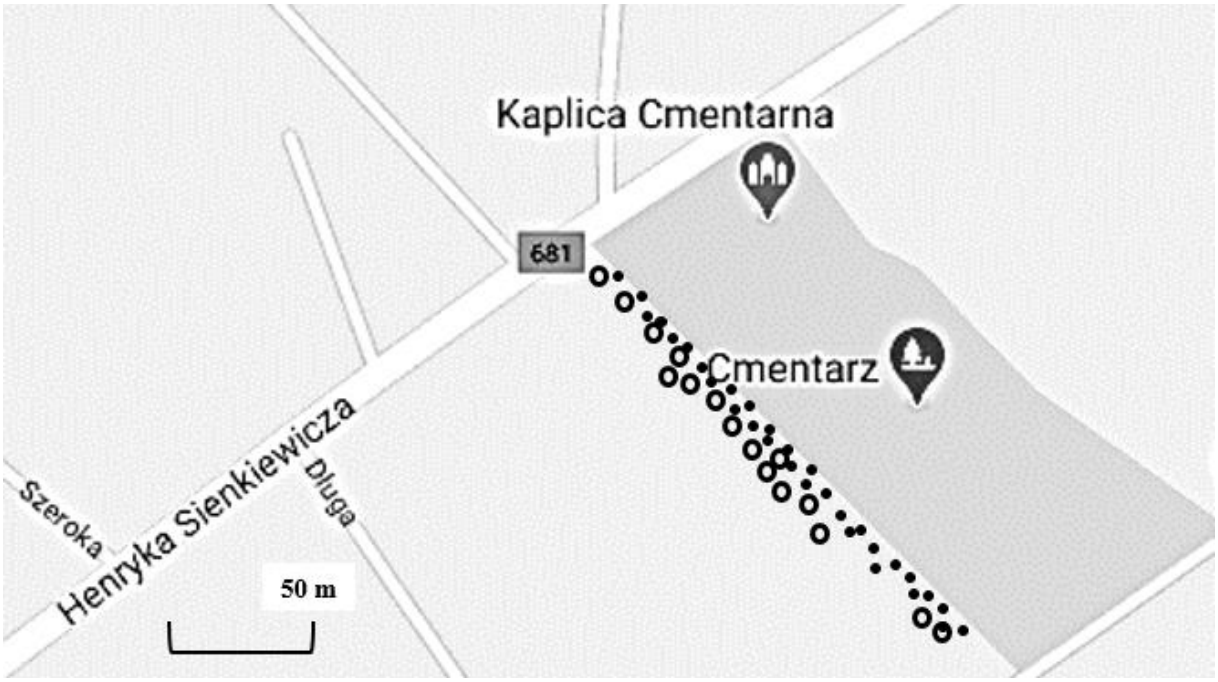

Figure 5. Location of invasive and expansive species *Robinia pseudoacacia* and *Urtica dioica* by the cemetery wall; Ciechanowiec, Sienkiewicza Street (by Sylwia Kiercul)

***** groups of individuals of *Robinia pseudoacacia* are marked with a black filled circle

****** groups of individuals of *Urtica dioica* species are marked with a white circle

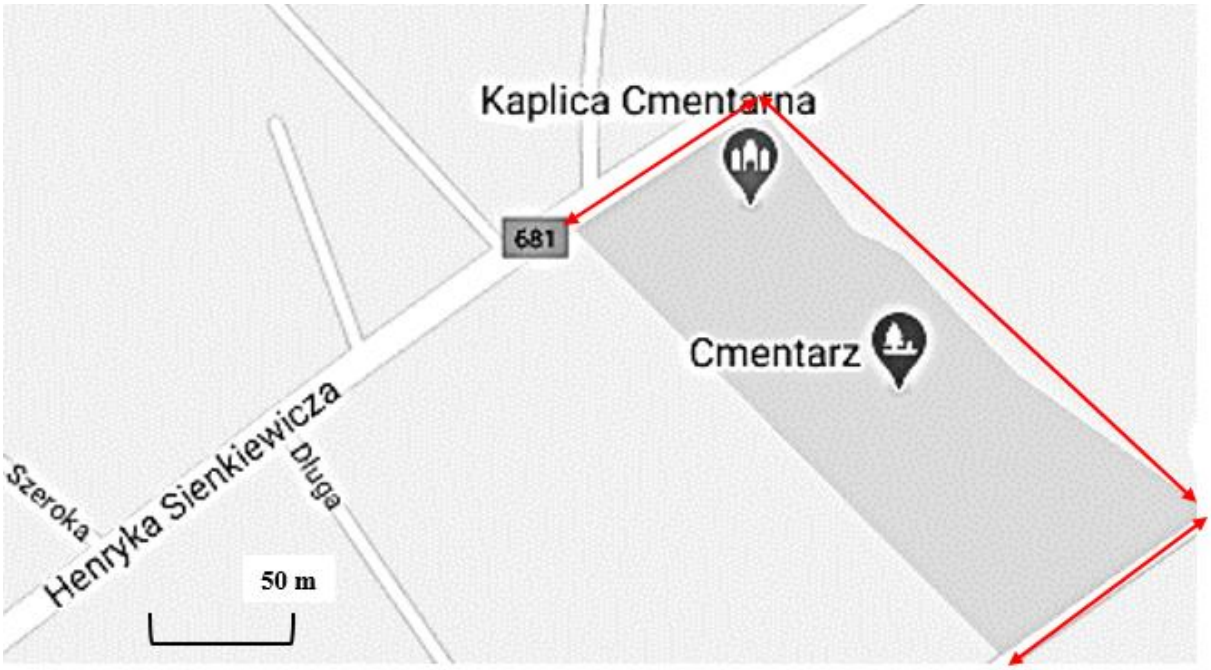

Figure 6. The scope of renovation of the cemetery walls in Ciechanowiec, Sienkiewicza Street (by Sylwia Kiercul)

Figure 7. *Asplenium ruta-muraria* and *Asplenium trichomanes* in the crevices of the cemetery wall in Ciechanowiec; Sienkiewicza Street (Photos by Sylwia Kiercul)

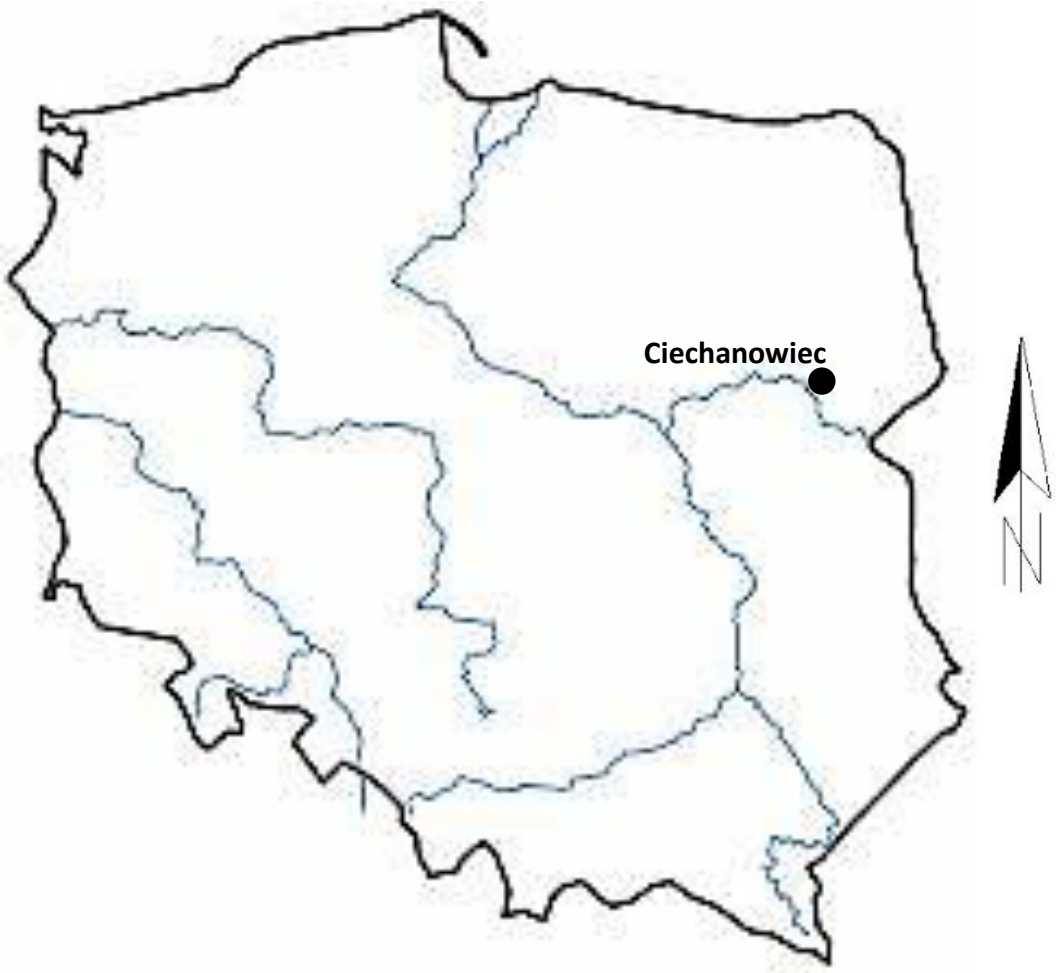

Figure 8. Location of the Ciechanowiec, Podlaskie Voivodeship in Poland (by Sylwia Kiercul)

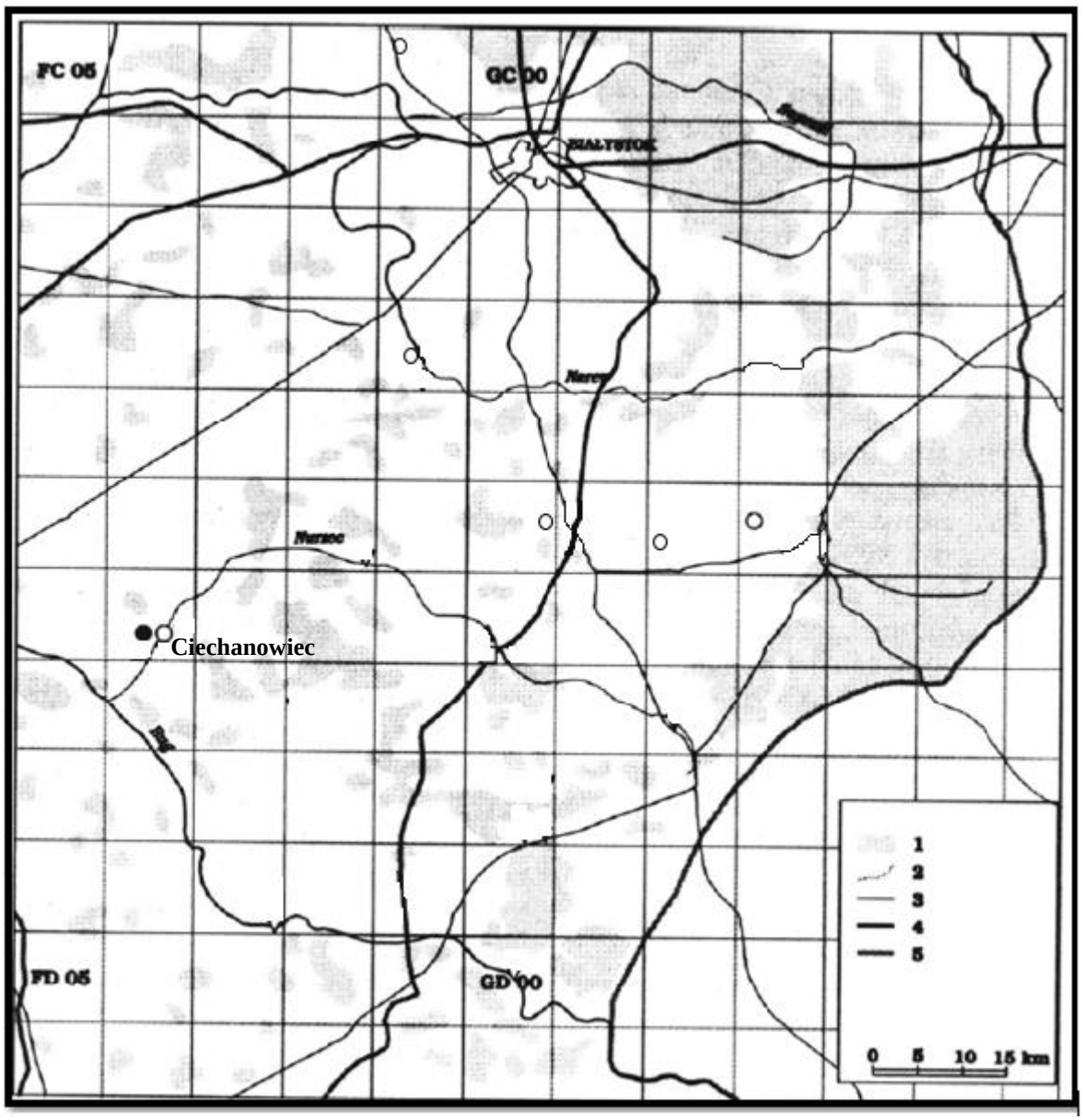

Figure 9. Location of all current *Asplenium ruta-muraria* and *Asplenium trichomanes* sites in the ruderal habitats on the Północnopodlaska Lowland area (after: Wołkowycki 2000, modified). In the presented ATPOL numbers are given for selected 10 × 10 fields

1 – forests, 2 – rivers, 3 – railway, 4 – main roads, 5 – border of Poland

* the black circle marks the all current locations of *Asplenium ruta-muraria*

** the white circle marks the all current locations of *Asplenium trichomanes*