

# Changes in mountain vascular plants of the ‘Jar rzeki Raduni’ nature reserve (Poland) within the last 50 years

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**Abstract.** ‘Jar rzeki Raduni’ is a landscape nature reserve created in 1972, which covers an area of 74,26 ha. The reserve protects the Radunia river gorge in the moraine upland of the Kashubian Lake District. In past, the reserve was an object of numerous botanical studies, and it was distinguished by a large share of mountain species. The main aim of this research was to define the current state of mountain species of the studied area compared to historical data. The study was carried out in 2017. Eight mountain species were noted: *Aconitum variegatum*, *Alnus incana*, *Bupleurum longifolium*, *Chaerophyllum hirsutum*, *Dryopteris expansa*, *Huperzia selago*, *Pleurospermum austriacum* and *Ribes alpinum*. The occurrence of five species was not confirmed: *Coeloglossum viride*, *Epipogium aphyllum*, *Melampyrum sylvaticum*, *Polygonatum verticillatum* and *Valeriana sambucifolia*.

**Key words:** mountain species in lowlands, Gdańsk Pomerania, Baltic region

## 1. Introduction

There are numerous publications referring to the topic of occurrence of mountain flora in lowlands (Jakubowska-Gabara & Jost-Jakubowska 1978; Ciaciura 1988; Zajac 1996; Buliński 2001; Herbichowa & Herbich 2001; Urbisz 2001; Sobisz *et al.* 2005; Więclaw & Ciaciura 2005; Szczecińska *et al.* 2006; Nowak *et al.* 2011; Podgórska 2012; Parusel *et al.* 2013; Fojcik & Wierzoń 2015; Parusel 2016). Especially, the Pomeranian region, with characteristic topographical relief created by the Pleistocene glacial and later denudation processes, is a proper area for mountain plant habitats. There is a crucial role of river valleys that are hardly available for agricultural purposes and partially also for forestry, thus, they contain some remaining fragments of naturally valuable communities with a lot of rare species. It concerns relict species, such as mountain plants in particular (Czubiński 1950). Their occurrence in the river valleys of Pomerania is

conditioned by microclimatic factors and high erosion, which makes the conditions similar to lower montane zones (Czubiński 1950; Pawłowska 1972; Herbich 1994, 1998).

Flora of Pomerania, in comparison to other parts of Polish lowlands, stands out with a significant share of mountain species, i.e., plants that have the center of their distribution range in the mountains of Central Europe. In Pomerania, mountain species differ in terms of the time of arrival, origin, migration routes and contemporary ranges of occurrence (Szafer 1930; Czubiński 1950; Markowski & Chojnacki 1982; Zajac 1996).

One of the most precious natural areas of Pomerania, where many representatives of mountain flora occur, is the ‘Jar Rzeki Raduni’ nature reserve (Wangerin 1919; Urbański 1930; Krawiec & Urbański 1935; Czubiński 1950; Markowski & Chojnacki 1982).

The main aim of this research was to define the current state of mountain species in the ‘Jar Rzeki Raduni’ nature reserve compared to historical data.

## 2. Material and methods

'Jar rzeki Raduni' is a landscape nature reserve created in 1972, which covers an area of 74,26 ha (Regulation 1972). This reserve protects the Radunia river gorge located on a small outwash plain in the moraine upland of the Kashubian Lake District (Rachocki 1974). The gorge of the Radunia river is 6 km long and reaches the depth of 40 m, slope inclination often exceeds 40 degrees. Vegetation of the reserve is dominated by oak-hornbeam forests (Herbichowa & Herbich 1982). Alongside the riverbed, riparian forests and some non-forest communities, such as forb and meadows communities, occur. The Radunia River Valley is also protected as Natura 2000 Special Area of Conservation (Regulation 2007).

In past, the reserve was an object of numerous botanical studies (Schultze 1880; Klinggräff 1885; Urbański 1930; Krawiec & Urbański 1935; Herbich 1974, 1994, 1998; Herbichowa & Herbich 1982, 1998; Markowski & Chojnacki 1982; Piotrowska 1982; Piotrowska & Stasiak 1982, 1984). A complete floristic list includes 537 species (Piotrowska & Stasiak 1982). Besides, a high species richness of the studied area is distinguished by a large share of mountain species (Piotrowska & Stasiak 1984; Herbich & Markowski 1998).

In 2017, field research was carried out in the whole area of nature reserve. Mountain species were located

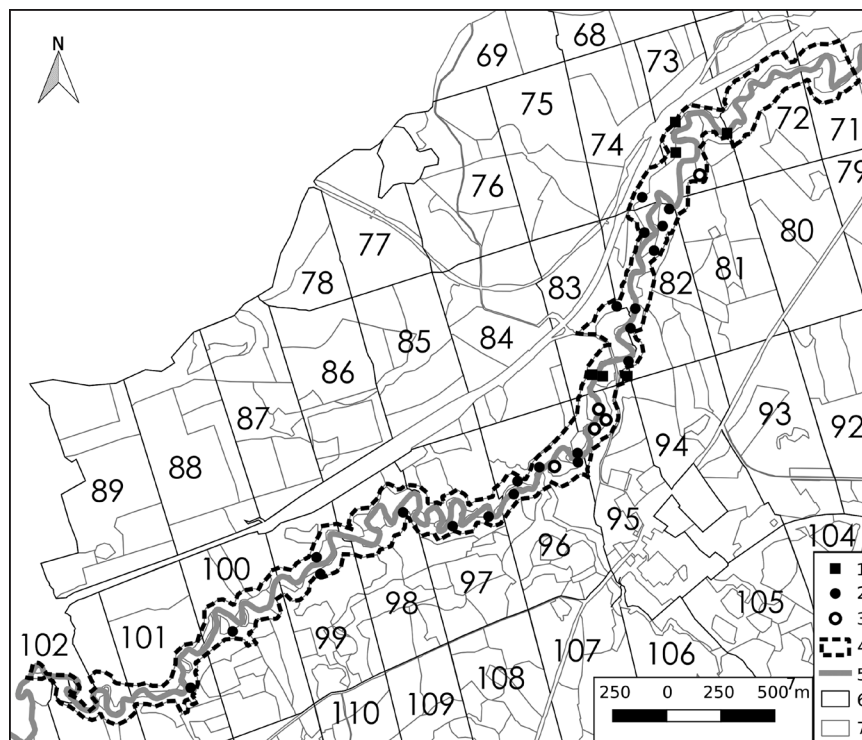
using Mobile Mapper GPS device. A population of a given species, occurring more than 25 m away from the other population of this species, was considered a single locality. The localities were next mapped using ArcGIS software.

Scientific names of species follow Mirek *et al.* 2002. A list of mountain species follows Zajac (1996). In case of *Dryopteris expansa*, mountain affiliation of this species was established after Szczeńsiak *et al.* (2009). *Dryopteris expansa* was also mentioned by Zajac (1996), but due to insufficient data it was not clearly identified as a mountain species. Earlier distribution of mountain species in the study area was determined based on the data from the years 1968-1972 (Piotrowska & Stasiak 1982). In the mentioned paper, *Acer pseudo-platanus* was claimed to be a mountain species, thus, it was taken into account in the present study, although currently it is not considered a mountain taxon (Zajac 1996).

## 3. Results

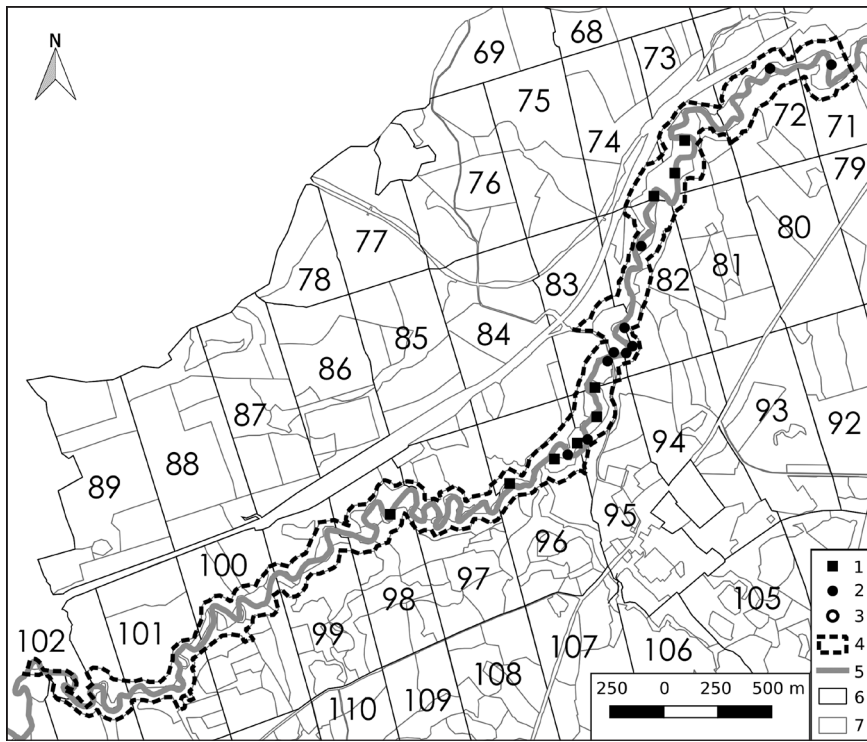
Eight mountain species were noted in the area of the "Jar rzeki Raduni" nature reserve.

*Aconitum variegatum* L. ssp. *variegatum* Gáy – widespread in the study area, 27 localities, mainly at the bottom of valley but also on slopes, in oak-hornbeam forests (Fig. 1).



**Fig. 1.** Distribution of *Aconitum variegatum* ssp. *variegatum* in the 'Jar rzeki Raduni' nature reserve

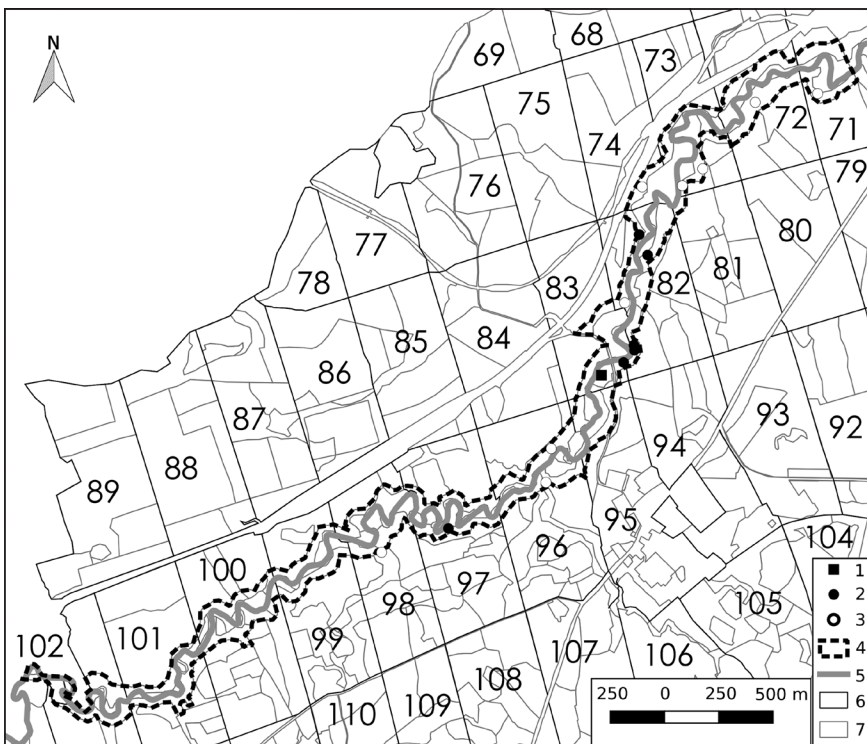
Explanations: 1 – new localities, 2 – confirmed localities, 3 – not confirmed localities, 4 – boundary of the reserve, 5 – the Radunia river, 6 – forest divisions, 7 – forest subdivisions



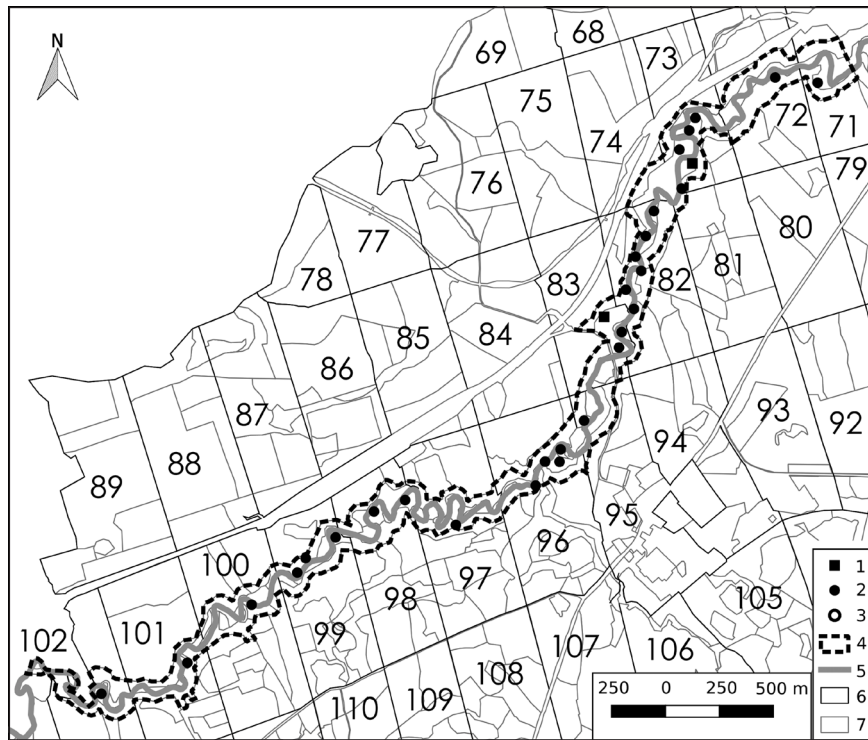
**Fig. 2.** Distribution of *Alnus incana* in the 'Jar rzeki Raduni' nature reserve  
 Explanations: see Fig. 1

*Alnus incana* (L.) Moench – 19 localities, a component of riparian forest stands, also many seedlings (Fig. 2).

*Bupleurum longifolium* L. – 7 localities, less than 100 individuals, on steep slopes, open oak-hornbeam forests (Fig. 3).



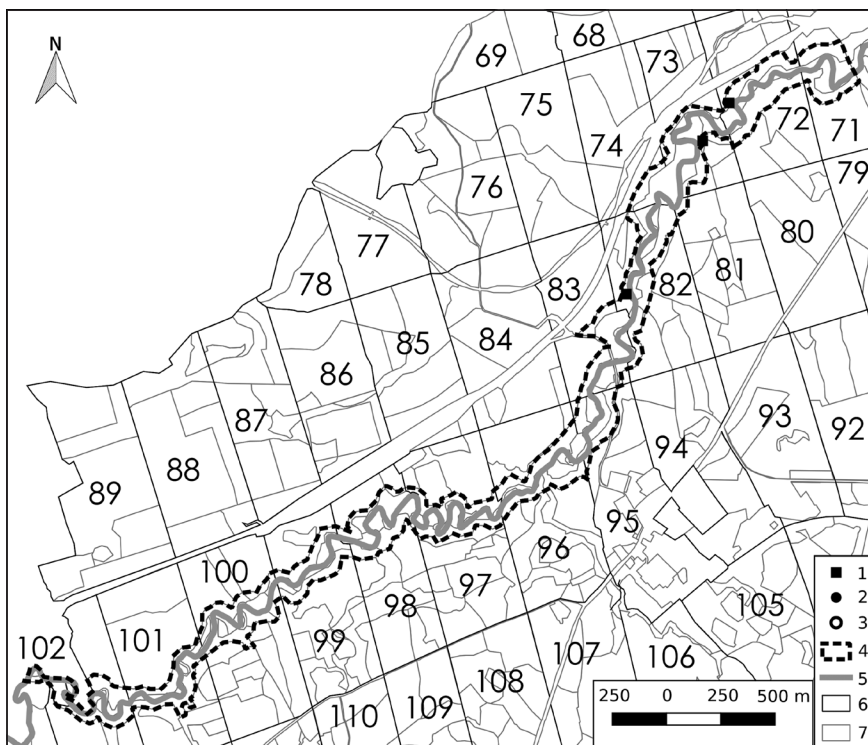
**Fig. 3.** Distribution of *Bupleurum longifolium* in the 'Jar rzeki Raduni' nature reserve  
 Explanations: see Fig. 1



**Fig. 4.** Distribution of *Chaerophyllum hirsutum* in the 'Jar rzeki Raduni' nature reserve  
Explanations: see Fig. 1

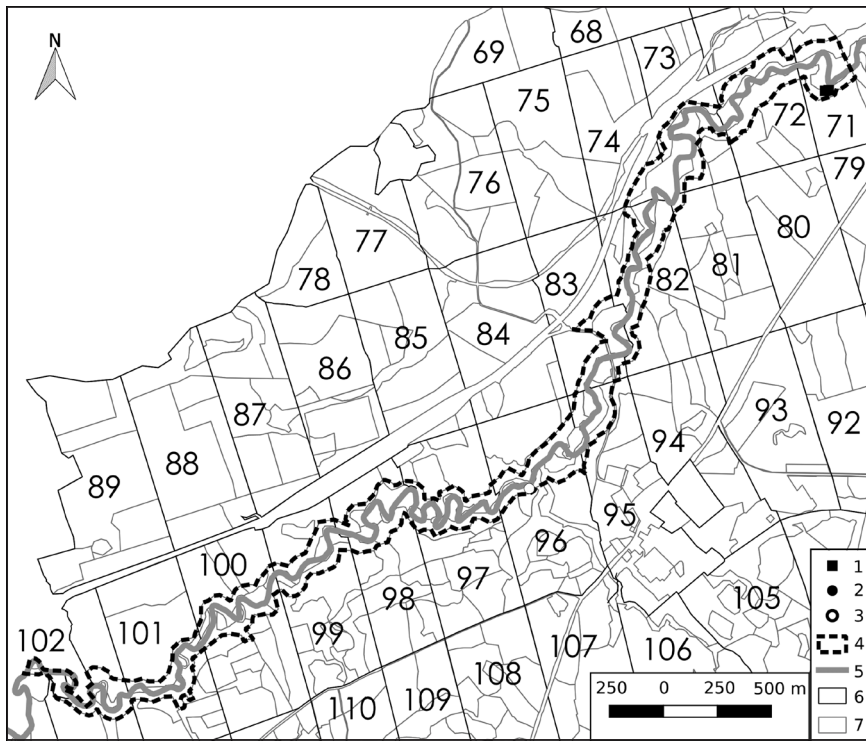
*Chaerophyllum hirsutum* L. – 30 localities, at the bottom of the valley, alongside the river, a dominant species of abandoned meadows and some gaps in riparian forest stands (Fig. 4).

*Dryopteris expansa* (C. Presl) Fraser-Jenk. et Jermy – 3 localities, less than 20 specimens, on slopes, in oak-hornbeam forests (Fig. 5).



**Fig. 5.** Distribution of *Dryopteris expansa* in the 'Jar rzeki Raduni' nature reserve  
Explanations: see Fig. 1

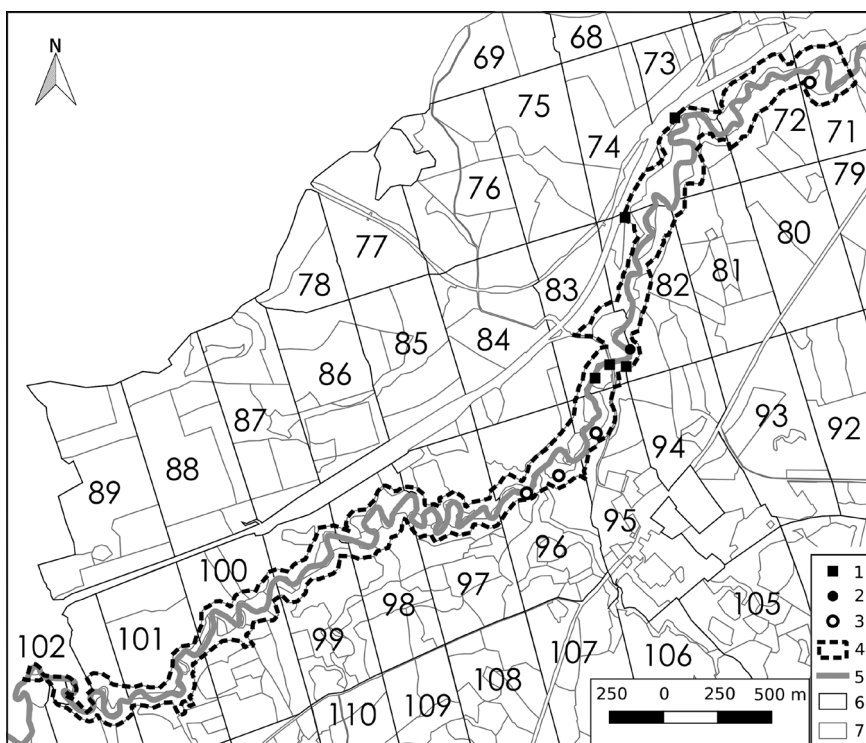




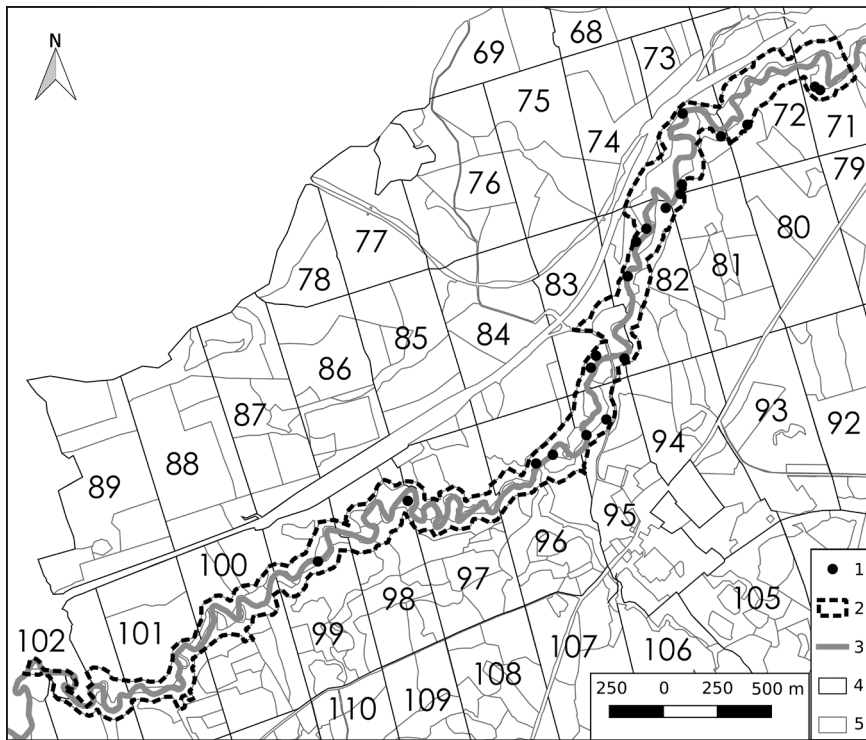
**Fig. 6.** Distribution of *Huperzia selago* in the ‘Jar rzeki Raduni’ nature reserve  
 Explanations: see Fig. 1

*Huperzia selago* (L.) Bernh. ex Schrank. – only 2 localities in the northern part of the study area, less than 10 specimens, on slopes, in oak-hornbeam forests (Fig. 6).

*Pleurospermum austriacum* L. – 6 localities, usually plants occur singly, rarely more than 100 individuals in locality, often in vegetative stage, mainly found in the middle part of the study area, on mild slopes and



**Fig. 7.** Distribution of *Pleurospermum austriacum* in the ‘Jar rzeki Raduni’ nature reserve  
 Explanations: see Fig. 1



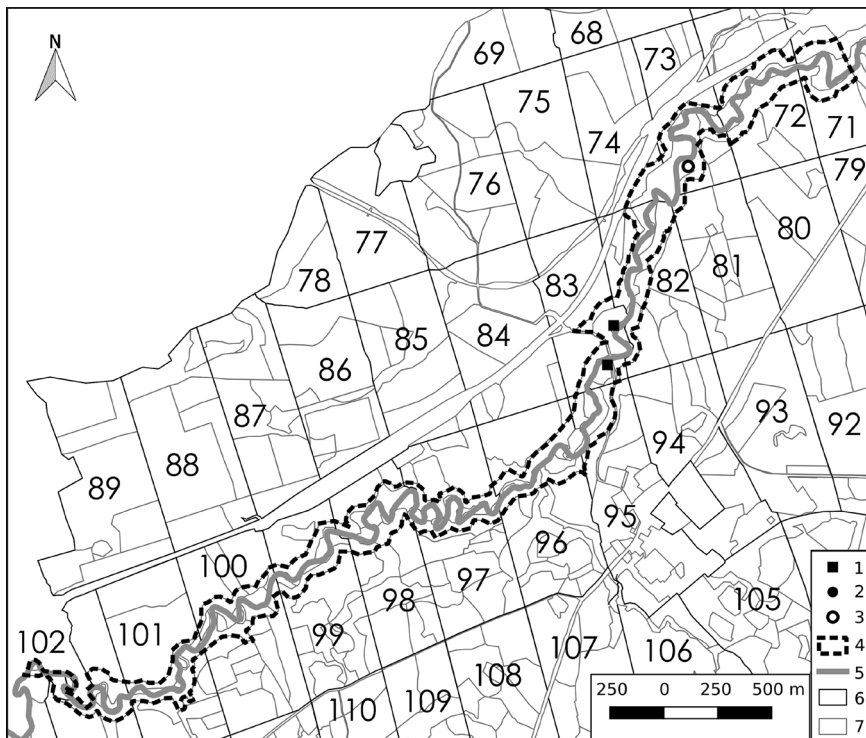
**Fig. 8.** Distribution of *Ribes alpinum* in the 'Jar rzeki Raduni' nature reserve

Explanations: 1 – current localities, 2 – boundary of the reserve, 3 – the Radunia river, 4 – forest divisions, 5 – forest subdivisions

at the bottom of the valley, in oak hornbeam forests (Fig. 7).

*Ribes alpinum* L. – 20 localities, mainly on slopes, in oak-hornbeam forests (Fig. 8).

Furthermore, the presence of one species considered to be a mountain species in previous studies was confirmed: *Acer pseudoplatanus* L. – numerous population (>1000 individuals) in the middle part of the reserve, at



**Fig. 9.** Distribution of *Acer pseudoplatanus* in the 'Jar rzeki Raduni' nature reserve. Currently, *Acer pseudoplatanus* is not considered to be a mountain species (Zając 1996)

Explanations: see Fig. 1

the bottom of the valley, 2 localities, forms own community – the regeneration stage of riparian vegetation (Fig. 9).

#### 4. Discussion

46 years have passed since the last complex botanical research in the ‘Jar rzeki Raduni’ nature reserve (Piotrowska & Stasiak 1982). In terms of global climate change, which impacts on species distribution, especially of mountain species (e.g. Lenoir & Svenning 2015; Konowalik *et al.* 2017; Vanneste *et al.* 2017; Alexander *et al.* 2018; Czortek *et al.* 2018), it was hypothesized that this problem concerns also mountain species in Polish lowlands. In fact, our result shows the decline of some mountain species localities, but this concerns only those species that previously formed small populations (Markowski & Chojnacki 1982; Herbich & Markowski 1998).

In previous research conducted in the ‘Jar rzeki Raduni’ nature reserve, 12 mountain species were noted (Schultze 1880; Abromeit 1898-1940; Piotrowska & Stasiak 1982, 1984). Seven of them were confirmed and one new was found in 2017. This new species for the flora of the reserve (Piotrowska & Stasiak 1982) is *Dryopteris expansa*. Species confirmed in the study area were: *Aconitum variegatum* ssp. *variegatum*, *Alnus incana*, *Bupleurum longifolium*, *Chaerophyllum hirsutum*, *Huperzia selago*, *Pleurospermum austriacum*, and *Ribes alpinum* (according to Piotrowska & Stasiak 1982). Also *Acer pseudoplatanus*, in previous studies claimed to be a mountain species, was confirmed. Currently this species is not considered as a mountain taxon (Zajac 1996), thus, the total number of mountain species ever mentioned in the study area is 12. Also, five species mentioned in old papers and not confirmed in later articles were not found in the present study: *Coeloglossum viride* (Schultze 1880, not found later), *Epipogium aphyllum* (Herbich 1974; Piotrowska & Stasiak 1982, 1984), *Melampyrum sylvaticum* (Schultze 1880, Abromeit 1898-1940, not found later), *Polygonatum verticillatum* (Piotrowska & Stasiak 1982, 1984), and *Valeriana sambucifolia* (Piotrowska & Stasiak 1982, 1984).

According to previous data (Piotrowska & Stasiak 1982), the number of localities of 5 mountain species in-

creased. It concerns the following species: *Alnus incana*, *Aconitum variegatum* ssp. *variegatum*, *Chaerophyllum hirsutum*, *Huperzia selago*, and *Pleurospermum austriacum*. Especially, the first of them considerably increased its population in the reserve. The number of localities of *Alnus incana* increased from 10 to 19, furthermore – all old localities were confirmed. For *Chaerophyllum hirsutum* and *Huperzia selago*, 2 new localities were found. Six new localities of *Aconitum variegatum* ssp. *variegatum* were found, but 5 were not confirmed. In case of *Pleurospermum austriacum*, 5 new localities were found, 2 were confirmed and 4 were not found. The previous number of localities of *Ribes alpinum* in the reserve is unknown, but it was noted as common (Piotrowska & Stasiak 1982).

There is only one species with the decreased number of localities (according to Piotrowska & Stasiak 1984): *Bupleurum longifolium* (6 out of 15 were confirmed, one new).

Species not confirmed (*Melampyrum sylvaticum*, *Coeloglossum viride*, *Epipogium aphyllum*, *Polygonatum verticillatum*, and *Valeriana sambucifolia*) occurred in the study area as relicts, and the reasons of their withdrawal are unclear. This could be caused by the climate change in recent years, but it is definitely related to dynamic geomorphological processes in the river valley, and changes in land use. Taking into account that their populations probably were residual, it is not expected that these species would return. The exception is *Epipogium aphyllum* that, given its ecology, is hard to observe in field (Taylor & Roberts 2011). The localities are not in danger of direct human activity, because the terrain is nearly inaccessible for tourists, the former tourist trail is damaged and not repaired. The danger for some localities could result from the process of natural secondary succession, started when the area was taken under protection. Also the impact of alien species is indiscernible, thus, the communities in the studied nature reserve are very well preserved.

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