

OCCURRENCE OF *PULSATILLA* HYBRIDS IN THE POLISH FLORA

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ABSTRACT. In order to investigate the current and historical distribution of hybrids of the genus *Pulsatilla*, field studies were carried out at potential hybrid sites, and literature and herbariums were searched. As a result of these studies, three hybrid taxa were found; *Pulsatilla* × *hackelii*, *Pulsatilla* × *intermedia* and *Pulsatilla* × *spuria*. The most common hybrid is *Pulsatilla* × *heckelii*, which has historically been found at twelve sites, currently found at four sites. *Pulsatilla* × *intermedia* has historically appeared in four locations concentrated in the region of Silesia. In the case of *Pulsatilla* × *spuria* it was found in six locations in western Poland, mainly concentrated in the Tuchola Forests.

KEY WORDS: Poland, distribution, hybrid taxon, *Pulsatilla* × *hackelii*, *Pulsatilla* × *spuria*, *Pulsatilla* × *intermedia*

INTRODUCTION

Hybridization, which usually refers to the process of crossing between different species is common in plants, and its role in evolution has been extensively studied (ARNOLD 1997, MALLET 2005). It is believed that the process of natural hybridization occurs in 40% of families and 16% of plant types (WHITNEY et al. 2010). The consequences of hybridization are diverse and may include an increase in genetic diversity, generate new genotypes or new species. Hybridization between common and rare species may result in the genetic assimilation or even extinction of rare species (ARNOLD et al. 2012). Therefore, hybrid identification and characterisation of the degree of hybridization are important and can contribute to the protection of rare species (WOLF et al. 2001).

Genus *Pulsatilla* (L.) Mill. is represented by 30 species occurring, in the temperate northern hemisphere of the Earth (AICHELE & SCHWEGLER 1957). Six species were reported in Poland, as yet: *P. alba* Rchb., *P. patens* (L.) Mill., *P. pratensis* (L.) Mill., *P. slavica* G. Reuss, *P. vernalis* (L.) Mill., and *P. vulgaris* Mill. (MIREK et al. 2002).

Hybridization in the *Pulsatilla* family is a frequent occurrence, and is well documented, in total,

13 hybrids from nine species have been described in Europe (HEGI & WEBER 1975). In the past, hybrids of the genus *Pulsatilla* were mentioned as an ingredient in Polish flora (TUTIN et al. 1964), however, these data were not later recognized (MIREK et al. 2002).

The aim of this work was to learn about the historical and current distribution of the *Pulsatilla* hybrids in Poland.

MATERIAL AND METHODS

Information on the sites used to make a map of the distribution of hybrids from the genus *Pulsatilla* in Poland comes from literature, herbaria, and own data from field studies. As part of the inventory of hybrid resources from the genus *Pulsatilla*, the following scientific herbariums were visited in Poland: KRA, KRAM, KTU, LBL, LOD, TRN, WA, WRSL (MIREK et al. 1997). In order to execute the map, the positions listed below were located in a network of squares with a side of 10 km according to the ATPOL system (ZAJĄC 1978). The hybrids are listed in alphabetical order, the nomenclature was adopted by HEGI & WEBER (1975) and AICHELE & SCHWAGLER (1957), parental species are given in parentheses.

RESULTS

LIST OF SPECIES AND LOCATION

- Pulsatilla* × *hackelii* Pohl. (*P. patens* × *P. pratensis*)
 BD83, Lower Silesia, Głogów, pine forest, 1 specimen, leg., det. F. Günther 05.18??, WRSS060414 (ut *P. vulgaris*).
 BE37, Lower Silesia, Wrocław, Miękinia-Mrozów, 3 specimens, leg., det. R. Uechtritz 28.06.1863, WRSS060429 (ut *Anemone pratensis*, *P. hackelii*).
 CE00, Lower Silesia, Sułów, Gruszczyca, 1 specimen, leg., det. F. Günther, 05.18??, WRSS060414 (ut *P. vulgaris*).
 CF05, Silesia, Opole, Nowa Wieś Królewska, 1 specimen, leg., det. R. Uechtritz, 24.07.1863, WRSS060422 (ut *Anemone pratensis*).
 DB77, Warmińsko-Mazurskie, Lubawa, sandy forest thickets, 2 specimens, leg., det. J. Modzelewska, 8.06.1975, LOD016166 (ut *Pulsatilla pratensis*).
 DB41, Pomorskie, Kwidzyn, Nicponia, 1 specimen, leg., det. H. Borurr, 08.1853, TRN (ut *Pulsatilla pratensis*).
 DE59, Łódzkie, Przedbórz, Góra Majowa, 1 specimen, leg., det. S. Lappe, 08.05.1970, LOD017912 (ut *Pulsatilla pratensis*).
 DF69, Cracow, Krzemionki, 2 specimens, leg., det. W. Kulczyński, 1876, KRAM134897 (ut *Pulsatilla nigricans* × *patens*, *Anemone patens*).
 DF69, Cracow, Krzemionki, 18 specimens, leg., det. A. Żmuda, 2.05.1909, KRAM005037 (ut *Pulsatilla nigricans* × *patens*, *Pulsatilla hackelii*).
 DF69, Cracow, Krzemionki, 3 specimens, leg., det. J. Krupa, 18??, KRAM134898 (ut *Pulsatilla nigricans* × *patens*, *Pulsatilla hackelii*).
 DF79, Cracow, Podgórze, 4 specimens, leg., det. J. Krupa, 18??, KRAM134899 (ut *P. vulgaris*, *nigricans* × *patens*).
 ED13, Mazovia, Kampinos National Park, Dąbrowa Stara, 1 specimen at the top of the dune about the southern exhibition, in a collection reminiscent of its character to *Peucedano-Pinetum*. In 2013, an excavation test was carried out as well as regenerations in the form of pile root reflections. Two individuals of *P. pratensis* grew in the close vicinity, and the occurrence of *P. patens* in the described location was administered in 1990.
 ED15, Mazovia, Kampinos Forest, 3 specimens, leg., det. R. Kobendza, 1952, WA0000066946 (ut *Pulsatilla*).
 ED16, Mazovia, Warsaw, Młociny, 6 specimens, leg., det. R. Kobendza, 11.05.1948, WA0000066947 (ut *Pulsatilla*).
 EE8201, Świętokrzyskie Mountains, Bocheński Mountain, Góra Bocheńska, 1 specimen on the edge of mixed forest (*Quercus roboris-Pinetum*), in the free area of trees and shrubs, in the vicinity

of a forest road (SZCZECIŃSKA et al. 2017, ŁAZARSKI et al. 2018).

FB86, Podlasie, Biebrza National Park, Carska Road, 3 specimens, located in the the western exhibition between about 70 years old subcontinental wild forest *Peucedano-Pinetum* and the Road (Fig. 1).

GB11, Podlasie, Giby, roadside, 1 specimen, leg., det. B. Sudnik, 10.10.1975, WA0000067088 (ut *Pulsatilla pratensis*).

GB12, Podlasie, Nożegary. Several specimens scattered along the road to Grodno (Torzewski, unpublished 2013), in a thermophilic margin at the edge of *Serratulo-Pinetum* (Pawlikowski, oral information 2017).

Pulsatilla × *intermedia* Lsch. (*P. patens* × *P. vernalis*)

CE00, Lower Silesia, Sułów, Gruszczyca, 1 specimen, leg., det. R. Uechtritz, 16.04.1860, WRSS060304 (ut *Anemone patens* × *vernalis*) (Fig 2).

CE00, Lower Silesia, Sułów, Gruszczyca, 1 specimen, leg., det. R. Uechtritz, 24.04.1860, WRSS060305 (ut *Anemone patens* × *vernalis*) (Fig 2).

CE00, Lower Silesia, Sułów, Gruszczyca, 1 specimen, leg., det. E. Baumann, 6.04.1890, WRSS060306 (ut *Anemone patens* × *vernalis*) (Fig 2).

CE00, Lower Silesia, Sułów, Gruszczyca, 2 specimens, leg., det. R. Uechtritz, 13.04.1854, WRSS060307 (ut *Anemone patens* × *vernalis*).



Fig. 1. *Pulsatilla* × *hackelii* in the Biebrza National Park (photo: K. Torzewski, 11.05.2016)



Fig. 2. Herbarium specimen of *Pulsatilla* × *intermedia* from locality in Gruszczyka, Lower Silesia (WRSS060304, WRSS060305, WRSS060306)

- CE85, Silesia, Opole, Świerkle, 1 specimen, *leg.*, *det.* H. Schmidt, 15.04.1887, WRSS060310 (ut *Anemone patens* × *vernalis*).
- CE85, Silesia, Opole, Świerkle, 1 specimen, *leg.*, *det.* H. Schmidt, 04.1881, WRSS060311 (ut *Anemone patens* × *vernalis*).
- CE59, Silesia, Gorzów Śląski, 1 specimen, *leg.*, *det.* R. Uechtritz, 1862, WRSS060312 (ut *Anemone patens* × *vernalis*).
- DF33, Silesia, Będzin, 1 specimen, *leg.*, *det.* R. Uechtritz, 21.03.1863 WRSS060313 (ut *Anemone patens* × *vernalis*).

Pulsatilla × *spuria* Camus (*P. pratensis* × *P. vernalis*)

- CC47, Kujawsko-Pomorskie, Nowa Wieś Wielka, 2 specimens, *leg.*, *det.* M.E. Grütter, 24.04.1886, TRN (ut *Pulsatilla pratensis* × *vernalis*).
- CB77, Tuchola Forests, 1 specimen, *leg.*, *det.* M.E. Grütter, 24.05.1886, TRN (ut *Pulsatilla pratensis* × *vernalis*).



Fig. 3. Herbarium specimen of *Pulsatilla* × *spuria* from locality in Gruszczyka, Lower Silesia (WRSS060303)

- CB77, Tuchola Forests, Lniano, forester's lodge, 1 specimen, *leg.*, *det.* M.E. Grütter, 14.05.1886, TRN (ut *Pulsatilla pratensis* × *vernalis*).
- CB77, Tuchola Forests, Lniano, 3 specimens, *leg.*, *det.* M.E. Grütter, 14.05.1891, TRN (ut *Pulsatilla pratensis* × *vernalis*).
- AD58, Lubuskie, Zielona Góra, 2 specimens, *leg.*, *det.* M.E. Grütter, 21.04.1886, TRN (ut *Pulsatilla pratensis* × *vernalis*).
- CE00, Lower Silesia, Sułów, Gruszczyka, 1 specimen, *leg.*, *det.* R. Uechtritz, 24.04.1860, WRSS060303 (ut *Anemone pratensis* × *vernalis*) (Fig. 3).

DISCUSSION

In the "Atlas of distribution of vascular plants of Poland" (ZAJĄC & ZAJĄC 2001), no hybrid from the genus *Pulsatilla* was considered due to numerous inaccuracies and the necessity of revision of the taxonomic material from Poland. Data on the occurrence of hybrid *Pulsatilla* sites in various regions of Poland can be found in numerous local floristic and phytosociological studies as well as scientific herbs. The

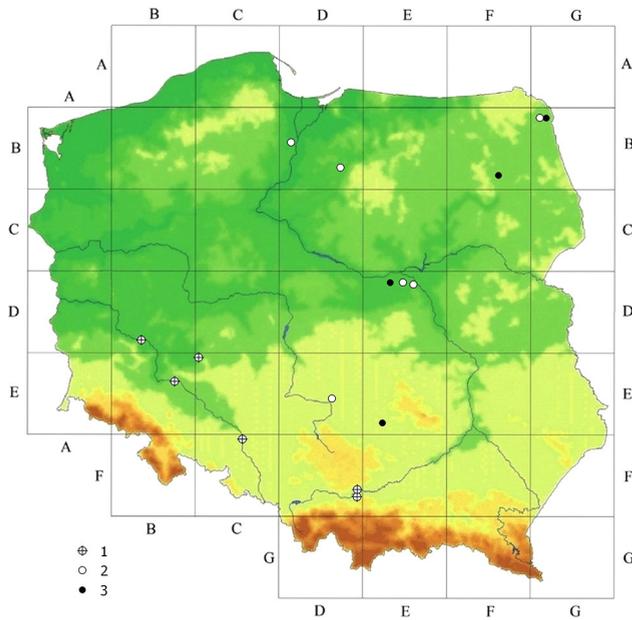


Fig. 4. Distribution of *Pulsatilla* × *hackelii* in Poland, in the ATPOL grid, based on literature, data herbarium and own research

Explanations: 1 – historical locations before 1945, 2 – locations from the period 1945–2000, 3 – contemporary locations after 2000.

analysis of these data shows that hybrids of the *Pulsatilla* genus are scattered throughout almost all of Poland, and their range coincides with the reach of mother plants. From seven possible hybrids, three were found, i.e. *Pulsatilla* × *hackelii*, *Pulsatilla* × *intermedia* and *Pulsatilla* × *spuria*.

The most common hybrid is *Pulsatilla* × *hackelii*, which covers a large part of the country (Fig. 4). Historically, it was found at twelve sites with a

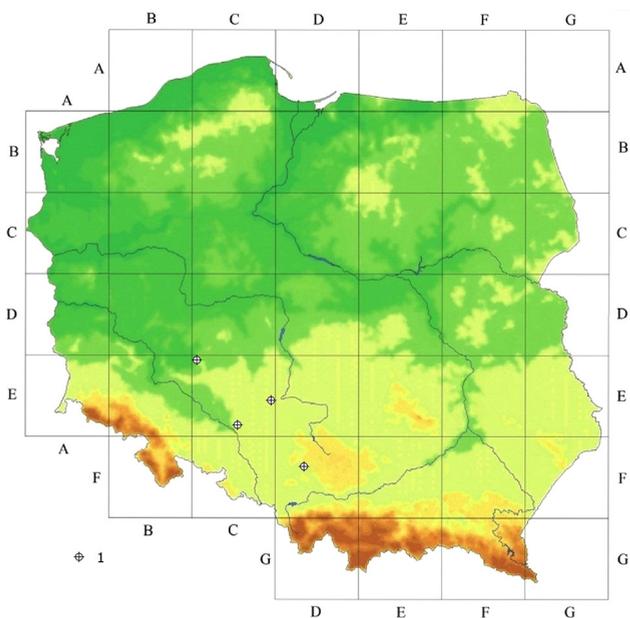


Fig. 5. Distribution of *Pulsatilla* × *intermedia* in Poland, in the ATPOL grid, based on the herbarium collections
Explanation: 1 – historical locations before 1945.

total of forty-seven individuals on fourteen herbarium sheets. Modernly, *Pulsatilla* × *hackelii* was found on four sites, on three stands single individuals were recorded, except for the position in the Biebrza National Park where three individuals were found. Positions of *Pulsatilla vulgaris* which was administered from Lower Silesia, after the revision of herbarium sheets should be considered *Pulsatilla* × *hackelii*.

Pulsatilla × *intermedia* has historically appeared in four localized concentrated in the region of Silesia (Fig. 5). In total, nine specimens were found on five herbarium sheets.

Pulsatilla × *spuria* has historically appeared in six locations in western Poland, mainly concentrated in Tuchola Forests (Fig. 5). In total, ten specimens were found on six herbarium sheets.

Current positions from *Pulsatilla* × *hackelii* have been recorded in forest communities: the continental mixed-bourgs *Quercus roboris*-*Pinetum*, the subcontinental fresh cave of *Peucedano*-*Pinetum*, or in the thermophilic reminiscent edge of its character to *Serratulo*-*Pinetum*. In the case of the other two hybrids *Pulsatilla* × *spuria* and *Pulsatilla* × *intermedia* due to the inability to read the herbarium labels from the end of the 19th century, the plant communities are not known. It should be assumed that they coincided with the place of parental plant occurrence and they were also overexposed pine forests or their edge.

The hybridization process increases when the size of the parent population or one of them decreases (MORGAN-RICHARDS et al. 2009), it may have a negative impact on parental species, which mainly causes concretion of hybrid competition (RHYMER & SIMBERLOFF 1996) or the production of hybrid offspring instead of own offspring (LEVIN et al. 1996). In the

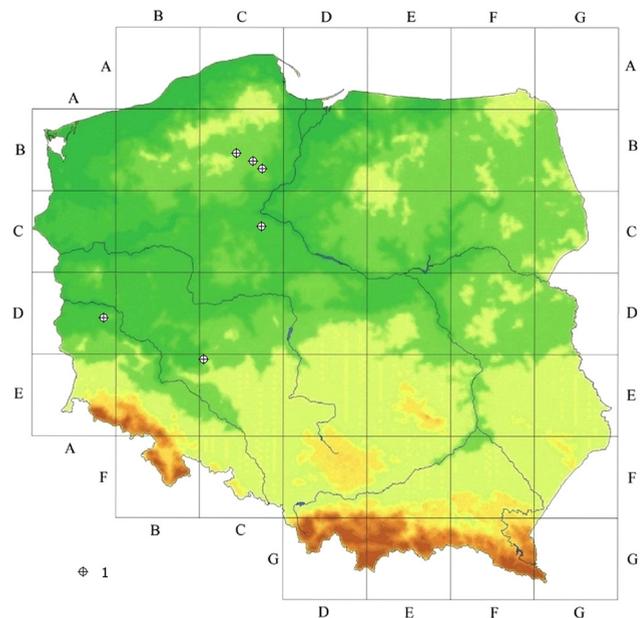


Fig. 6. Distribution of *Pulsatilla* × *spuria* in Poland, in the ATPOL grid, based on the herbarium collections
Explanation: 1 – historical locations before 1945.

case of the *Pulsatilla* genus, the impact of hybrids on parental species is poorly studied and is mainly based on assumption. According to the report performed by KREJČOVÁ (2014), the impact of *P. × hackelii* on the parental species *P. patens* and *P. pratensis*, due to its general low frequency and significantly reduced fertility, is negligible. It can therefore be assumed that the other hybrids found in Poland are similar.

The data presented indicate that hybrids of the genus *Pulsatilla* were and still are rare components of Polish flora. Although the statements are scattered across most of Poland, they were most likely wider than the locations indicated. It can also be assumed that the process of resigning parental species *P. patens* and *P. vernalis* from south-western Poland began in the second half of the 19th century.

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