Polish Botanical Journal 56(1): 81–84, 2011

BOTRYCHIUM VIRGINIANUM (OPHIOGLOSSACEAE) REDISCOVERED IN POLAND

PAWEŁ PAWLIKOWSKI

Abstract. *Botrychium virginianum* (L.) Sw., a species considered extinct in Poland, was rediscovered in the Puszcza Augustowska forest in 2010. The species grew along a forest dirt road crossing a natural, moist broadleaf-spruce forest *Tilio-Carpinetum circaetosum*. Its population consisted of 14 shoots only, and the species should be considered critically endangered in Poland by IUCN criteria.

Key words: *Botrychium virginianum*, endangered species, distribution, habitat, Ophioglossaceae, Poland

Paweł Pawlikowski, Department of Plant Ecology and Environmental Conservation, Institute of Botany, University of Warsaw, Al. Ujazdowskie 4, 00-478 Warszawa, Poland; e-mail: p.pawlikowski@uw.edu.pl

INTRODUCTION

Botrychium virginianum (L.) Sw. is a heterosporous perennial fern 20–80 cm high. It has a single leaf divided into two parts: broadly triangular, wider than long, sessile, membranous, 3 to 4-pinnate sterile lamina, and a fertile panicle of spikes (Rothmaler 1993) (Fig. 1). The gametophyte is myco-heterotrophic.

Three subspecies are recognized within the wide distribution range of the species. *Botrychium virginianum* subsp. *virginianum* is widespread in Northern America from southern Canada to the southern United States (e.g., Arizona, Texas, Florida). In the eastern United States it is the most common fern of the genus *Botrychium* Sw., while in East Asia it is a rare taxon recorded in several mountain ranges only (Himalayas, Pamir Mts, mountains in China and Japan). *Botrychium virginianum* subsp. *europaeum* (Ĺngstr.) Javorka is restricted to the boreal zone and is found both in North America (Canada and some U.S. states, mainly those adjacent to Canada) and Eurasia (from Sweden, Germany and Switzerland to Western Siberia, with sparse localities further eastwards). It is the only subspecies of *B. virginianum* that occurs in Europe (Hultén & Fries 1986a). It can be found primarily in the countries adjacent to the Baltic Sea and in northern Russia, and southward to northern Ukraine, the Carpathians and the Alps (Jalas & Suominen 1972). The third subspecies [*B. virginianum* subsp. *meridionale* (Butters) R. T. Clausen] is known from Mexico (Hultén & Fries 1986b). In the Americas the species extends as far south as Bolivia and Brazil (Davis *et al*. 2005), but there are no detailed taxonomical data on these populations and it is unknown which subspecies occur(s) there.

Botrychium virginianum reaches the southwestern limit of its distribution in Poland and other Central European countries (Hultén & Fries 1986a). It is considered a rare, declining species there, and it is assigned the highest threat status in, for example, Germany (Anonymous 2011), Lithuania (Naujalis 2007) and Belarus (Blazhevich & Dubovik 2005). In Poland, where it used to occur at five sites in the northeastern part of the country, it was first designated critically endangered (CR, Zarzycki 2001) but then was moved to the extinct (EX) category (Zarzycki & Szeląg 2006).

RESULTS

On 30 June 2010, a previously unknown population of *Botrychium virginianum* subsp. *europaeum* was found in the Puszcza Augustowska forest in the

northeasternmost part of Poland, in the Starożyn Nature Reserve (Fig. 2). The population occurred on both sides of a seldom used forest dirt road, occupying roadsides along a distance of *ca* 15 m in moist broadleaf-spruce forest *Tilio-Carpinetum circaetosum*. It is located in square GB31 of the ATPOL grid square system (Zając 1978).

The population consisted of 14 shoots, including one fertile stem (40 cm high) with a sporophyll, and five juvenile individuals. The majority of the ferns grew on mineral-organic soil (11–18% soil organic matter) developed from sandy substratum transported there from the outside in order to improve the road, mixed with local soil rich in humus. Soil pH was 6.82 (measured in KCl) and 7.26 (measured in H_2O), and the organic matter content of soil ranged from 10.9% to 18.4%. The adjacent mixed broadleaf-spruce moist forest showed natural features, with an ancient tree stand (some trees more than 120 years old)

Fig. 1. *Botrychium virginianum* (L.) Sw. in the Starożyn Nature Reserve (30 June 2010).

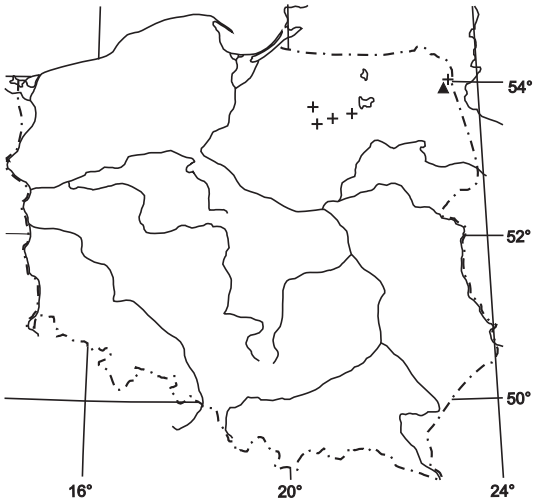

Fig. 2. Distribution of *Botrychium virginianum* (L.) Sw. in Poland: **[triangle]** – new locality; + – extinct locality.

and a large amount of decaying wood. The upper forest layer consisted of lime, spruce, ash, maple and oak, while the lower tree and shrub layers were dominated by hazelnut and spruce.

The ferns grew in moderate shade, with lateral light from above the road. Among the species of the forest floor, *Oxalis acetosella* L. predominated along with other (mainly broadleaf forest) plants such as *Anemone nemorosa* L., *Athyrium filix-femina* (L.) Roth., *Carex digitata* L., *C. remota* L., *Circaea alpina* L., *Equisetum sylvaticum* L., *Galeobdolon luteum* Huds., *Galium odoratum* (L.) Scop., *Hepatica nobilis* Schreb., *Mycelis muralis* (L.) Dumort., *Prunella vulgaris* L., *Rubus saxatilis* L. and saplings of lime and ash. The herb layer cover varied from 20 to 70%, and the moss layer cover [mainly *Oxyrrhynchium hians* (Hedw.) Loeske and numerous other Brachytheciaceae species as well as *Thuidium tamariscinum* (Hedw.) Schimp.] ranged from nearly 0% to 75%.

Discussion

Mixed forests are the main habitat of *Botrychium virginianum* also in Belarus (Blazhevich & Dubovik 2005), Lithuania (Naujalis 2007), other Baltic countries (Laasimer *et al*. 1993) and Siberia (Krasnoborov 1988). In Poland, *Botrychium*

virginianum used to grow in this type of forest as well (Abromeit *et al*. 1931–1940; Sokołowski 1978). Some authors have reported the species from forest paths and roads (Kotiranta *et al.* 1998; Blazhevich & Dubovik 2005; Priedîtis 2007), as I report here. According to Kotiranta *et al.* (1998) the renewal of its populations requires some kind of natural or manmade disturbance (e.g., severe storms that blow down tree stands, forest-fires, logging), after which numerous young plants can be seen. Krasnoborov (1988) noted the occurrence of *B. virginianum* in clear-cut areas in Siberian forests.

The number of individuals I encountered seems high as compared to the number of individuals recorded from localities of *Botrychium virginianum* in adjacent countries, where usually single or a few individuals were noted (Blazhevich & Dubovik 2005; Naujalis 2007; Priedîtis 2007). In Finland, populations of several hundred individuals have been recorded in recent years (Kotiranta *et al.* 1998).

Of the 13 localities of *Botrychium virginianum* in Lithuania, only 3 have been confirmed recently. One of them was near the village of Dubičiai (Dubicze) in the Varėnos (Orany) region of Lithuania, close to the state border with Belarus; that is *ca* 25 km from the Polish border. In Belarus the species occurred recently in four localities in eastern and northern parts of the country, more than 300 km from Poland (Blazhevich & Dubovik 2005). It is much more common but still rare in Latvia and Estonia (Laasimer *et al*. 1993), as well as in Finland. In the southern part of Finland, *Botrychium virginianum* has drastically declined in recent years (Kotiranta *et al.* 1998). In Germany the species is known from the Bavarian Alps only (Anonymous 2011).

All four localities of *Botrychium virginianum* in Masuria and Warmia Province in Poland (Puszcza Piska forest and Puszcza Napiwodzko-Ramucka forest), recorded in 1881–1922 (Abromeit *et al*. 1931–1940) are considered extinct (Zając & Zając 2001; Zarzycki 2001). One of the sites (near Ustrych Lake, Abromeit *et al*. 1931–1940) was destroyed in the 1920s by timber stockpiling in a place where the fern was noted.

Since then, only one locality of *Botrychium virginianum* has been recorded in Poland: broad-leaf-mixed forest on a mineral island within a mire southwest of Wiłkokuk Lake, Puszcza Augustowska forest. A few individuals in one clump were recorded there (Sokołowski 1978; A. W. Sokołowski, pers. comm. in 2010). That locality also appears to be extinct, since the tree stand was clear-cut there in the early 1990s, and oak, spruce, and an admixture of alien species (beech and black cherry) were planted. My detailed exploration in June 2010 along with less regular surveys in 2003–2007 did not reveal the presence of the species at this site.

The newly discovered population in the Starożyn Nature Reserve is 17 km distant from the extinct locality at Wiłkokuk Lake. The present locality, with slightly more than a dozen individuals, is the only one persisting in Poland. According to the IUCN criteria for threatened species (Anonymous 2010), the species should be assigned CR (critically endangered) status, since it meets criterion D.

ACKNOWLEDGEMENTS. I thank the anonymous reviewer for helpful remarks on the manuscript.

REFERENCES

ABROMEIT J., NEUHOFF W. & STEFFEN H. 1931–1940. Flora von Ost- und Westpreussen. **2**. Kommissionverlag Gräfe und Unzer, Königsberg.

ANONYMOUS 2010. Guidelines for Using the IUCN Red List Categories and Criteria. Version 8.0. IUCN Standards and Petitions Subcommittee. [August 2010]. http://intranet.iucn.org/webfiles/doc/SSC/RedList/RedListGuidelines.pdf.

ANONYMOUS 2011. FloraWeb – Daten und Informationen zu Wildpflanzen und zur Vegetation Deutschlands. Bundesamt für Naturschutz. [April 2011]. http://www.floraweb.de/pflanzenarten/pflanzenarten.html.

BLAZHEVICH R. Y. & DUBOVIK D. V. 2005. Grozdovnik virginskiď *Botrychium virginianum* (L.) Sw. In: G. P. PASHKOV, L. V. KALENDA, V. N. LOGVIN & A. M. PETRIKOV (eds), *Krasnaya Kniga Respubliki Belarus*. *Rasteniya*, pp. 35–36. Belaruskaya Entsyklapedyya imeni Petrusya Brovki, Minsk.

DAVIS C. C., ANDERSON W. R. & WURDACK K. J. 2005. Gene transfer from a parasitic flowering plant to a fern. *Proceedings of the Royal Society, B* **272**: 2237–2242.

HULTÉN E. & FRIES M. 1986a. Atlas of North European vascular plants. **1**. Koeltz Scientific Books, Königstein.

HULTÉN E., FRIES M. 1986b. Atlas of north European vascular plants. **3**. Koeltz Scientific Books, Königstein.

JALAS J. & SUOMINEN J. (eds) 1972. Atlas Florae Europeae. Distribution of vascular plants in Europe. **1**. Psilotaceae to Azollaceae. Suomalaisen Kirjallisuuden Kirjapaino Oy, Helsinki.

KRASNOBOROV I. M. (ed.) 1988. Ophioglossaceae – Uzhovnikovye. In: I. M. KRASNOBOROV (ed.), *Flora Sibiri. Lycopodiaceae – Hydrocharitaceae*, pp. 48–52. Nauka, Novosibirsk.

KOTIRANTA H., UOTILA P., SULKAVA S. & PELTONEN S.-L. (eds) 1998. Red Data Book of East Fennoscandia. Ministry of Environment, Finnish Environment Institute, Botanical Museum, Finnish Museum of Natural History, Helsinki.

LAASIMER L., KUUSK V., TABAKA L. & LEKAVIČIUS A. (eds) 1993. Flora of the Baltic Countries. Compendium of vascular plants. **1**. Estonian Academy of Sciences, Latvian Academy of Sciences, Lithuanian Academy of Sciences, Tartu.

NAUJALIS J. R. 2007. Virgininis varpenis. *Botrychium virginianum* (L.) Sw. In: V. RAŠOMAVIČIUS (ed.), *Lietuvos raudonoji knyga*, p. 393. Leidykla Lututë, Kaunas.

PRIEDÎTIS N. 2007. Sugu enciklopçdija. Latvijas daba. Augi. SIA Gandrs. [August 2010]. http://www.latvijasdaba.lv/augi.

ROTHMALER W. 1993. *Botrychium* Swartz. In: T. G. TUTIN, N. A. BURGES, A. O. CHATER, J. R. EDMONDSON, V. H. HEYWOOD, D. H. VALENTINE, S. M. WALTERS & D. A. WEBB (eds), *Flora Europaea*. **1**: 8–9. Cambridge University Press, Cambridge.

SOKOŁOWSKI A. W. 1978. Projektowany rezerwat Wiłkokuk w Puszczy Augustowskiej. *Chrońmy Przyr. Ojczystą* **34**(1): 60–65.

ZAJĄC A. 1978. Atlas of distribution of vascular plants in Poland (ATPOL). *Taxon* **27**(5–6): 481–484.

ZAJĄC A. & ZAJĄC M. (eds) 2001. Distribution atlas of vascular plants in Poland. Laboratory of Computer Chorology, Institute of Botany, Jagiellonian University, Kraków.

ZARZYCKI K. 2001. *Botrychium virginianum* (L.) Swartz – podejźrzon wirginijski. In: R. KAŹMIERCZAKOWA & K. ZARZYCKI (eds), *Polish red data book of plants. Pteridophytes and flowering plants*, pp. 45–46. Polish Academy of Sciences, W. Szafer Institute of Botany & Institute of Nature Conservation, Kraków (in Polish with English summary).

ZARZYCKI K. & SZELĄG Z. 2006. Red list of the vascular plants in Poland. In: Z. MIREK, K. ZARZYCKI, W. WOJEWODA & Z. SZELĄG (eds), *Red list of plants and fungi in Poland*, pp. 11–20. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.

Received 12 October 2010