

New location of the moss *Buxbaumia viridis* in the Białowieża Forest

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Abstract. This paper describes a new occurrence and location of the green shield moss *Buxbaumia viridis* (Moug. ex Lam. & DC.) Brid. ex Moug. & Nestl. in the Białowieża Forest. One sporophyte was found on a decaying spruce log. However, its existence and the present environmental conditions of the site are threatened by the death of spruce trees. The dying of the spruce trees is expected for the near future and will lead to altered shade conditions impacting on the shield moss.

Keywords: green shield-moss, protected species, threatened species, Habitat Directive

1. Introduction

In the flora of Poland, the genus *Buxbaumia* is represented by two moss species, that is, green shield-moss *Buxbaumia viridis* (Moug. Ex Lam. & DC.) Brid. ex Moug. & Nestl. and bug-on-a-stick *Buxbaumia aphylla* Hedw. (Ochyra et al. 2003).

Until recently, within the Białowieża Forest, only the occurrence of *B. aphylla* – the species prevalent in lowland Poland – was observed, where it grows on mineral soils in pine forests (Szafran 1957, Atherton et al., 2010).

In contrast, *Buxbaumia viridis* occurs rarely in Poland, mainly in the Carpathians and the Sudety Mts., as well as in Poland's lake districts (Szafran 1957; Szmajda et al. 1991; Chachuła, Vončina 2010; Hajek 2008, 2010, 2012). The species was also reported from the Świętokrzyskie Mts. (Stebel et al. 2013) and the Roztocze Region (Fudali et al. 2015). In the Białowieża Forest, it was found only once (management unit 250D) (Szczepaniuk, Kucharzyk 2016). *B. viridis* grows on decaying wood (mainly spruce and fir, sporadically beech), and it rarely occurs on humus and mineral substrates (Hajek 2012; Vončina 2012). This species, in addition to the appropriate soil, requires specific habitat conditions, that is, high and constant air humidity, which is why it prefers shady forests, slightly transformed as a result of forest management (Hajek 2012; Kozik, Vončina 2012; Vončina 2012).

B. viridis is vulnerable to extinction both in Poland (Żarnowiec et al. 2004) and throughout Europe (Schumacker, Martiny 1995). In Poland, it is subject to strict species protection (Regulation 2014). At the European level, it is also protected as the species included in Annex II of the Habitats Directive (Directive 1992).

The present study aimed to compare the newly discovered site of *Buxbaumia viridis* with those considered typical for this species, as well as to determine site threats and its protection prospects.

2. Methods

The report on the newly discovered *Buxbaumia viridis* site within the Białowieża Forest – located in the landscape reserve (Rezerwat krajobrazowy im. Prof. Władysława Szafera), forest management unit 448D (WGS 84: 52.696 ° N, 23.772 ° E, approx. 170 m ASL) – was prepared in May 2016, based on the study by Vončina (2012). The decomposition stage of deadwood, where *B. viridis* was found, were assessed in line with the scale proposed by Zielonka (2006). Scientific classification of moss species observed was based on Ochyra et al. (2003). The stand layers were distinguished consistent with Mueller-Dombois and Ellenberg (1974).

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3. Results

In May 2016, in the Białowieża Forest, the next (second) site of *Buxbaumia viridis* was found - with one sporophyte of this species. The specimen grew on a decomposing (6th stage) spruce log, about 60 cm thick. Over 90% of the log's surface was covered by a single-layered, loose cover of mosses. In the immediate vicinity of the sporophyte, grew the Silesian Feather-moss *Herzogiella seligeri* (Brid.) Z. Iwats. and hypnum moss *Hypnum cupressiforme* Hedw. Potential *B. viridis* sites, that is, other dead logs lay 20–30 m away. The observed position was located on a hillside, gently sloping towards the north-west slope of one of the kames covered with *Tilio-Carpinetum typicum*, with about 10% spruce share (as observed in 2016). The age of the stand, where *B. viridis* site was discovered, was 157 years (according to the forest management plan). In the place of species occurrence, the total canopy cover accounted for 60%. The density of the stand's first floor was 40%, and that of the lower layer was 20%. The coverage of shrub and undergrowth layers was 20%. The total coverage of tree, undergrowth and shrub layers was 70%. In the immediate vicinity of the discussed moss site, there were numerous gaps, formed due to spruce dying/falling down, which resulted in a large diversity of microhabitats. At the same time, with the progressive decline of the upper storey of the stand, a dynamically growing, several-meter-tall hornbeam and spruce regeneration was observed. Even in the case of decline of so far enduring spruces, the coverage of trees/shrubs layers around the *Buxbaumia viridis* site should not fall below 50%.

The *B. viridis* site observed was located within the area where currently no forest management is carried out. On the other hand, in the immediate vicinity of the site, there were observed traces of tree felling operations (individual stumps), performed at least a dozen or so years ago.

In November and December 2016, no sporophytes of *Buxbaumia viridis* were found on the site discovered in May 2016.

4. Discussion and conclusions

The *Buxbaumia viridis* site reported from the Białowieża Forest differs in terms of the terrain from other sites of this species – usually found in ravines, erosion valleys, slopes, and so on. (Hajek 2010; Vončina, Chachuła 2012; Vončina 2012; Zarzecki 2012). The other site of *B. viridis* – earlier observed in the Białowieża Forest (Szczepaniuk, Kucharzyk 2016), was found within relatively flat terrain. Therefore, the microclimate at both *B. viridis* sites in the Białowieża Forest is mostly shaped by forest stand conditions, and the disturbance of the stand stability can have a negative impact on the population of this valuable moss species.

At present, the principal threat to the above described *B. viridis* site is progressive breakdown of the spruce stand growing

around, which is directly caused by the European bark beetle outbreak. Nevertheless, the process of spruce dieback observed is coming to an end, and in the perspective of the next few years, an increase in ground shading is expected – as a result of the hornbeam undergrowth development. Even though current stand microclimatic conditions have been adversely affected by spruce vanishing, in the long-term perspective, this can have a positive effect on the *B. viridis* population, in view of an increased availability of deadwood providing microhabitat for this species in the next dozen or several dozen years.

The flora of the Białowieża Forest, and especially that of the Białowieża National Park, is one of the most studied/well-known subjects in Poland. On the other hand, however, *B. viridis* specimens as a rule occur individually (hardly ever in larger numbers), are of small size, and are not found at the same site every year (Stebel 2004; Vončina 2012). These factors may be the cause of low detection of this species.

It is worth noting that the Białowieża's stand with *B. viridis* described by Szczepaniuk and Kucharzyk (2016), was located in the managed forests, whereas *B. viridis* site described in this paper was situated in the stand in the advanced stage of partial breakdown, where the conditions for the development of this moss species seemed worse when compared to some managed forests. Cieśliński et al. (1991) consider *B. viridis* as the relic of primeval forest. The site described in the present study, was found in the area intensively managed in the past, and the main form of exploitation was not tree cutting, but livestock grazing (Czerwiński 1968; Sokołowski 1996). Finding *B. viridis* sites in forests as such provokes reflection on whether tree stands with *B. viridis* should inevitably be excluded from economic and tourist use, as proposed by Stebel (2004) and Vončina (2012), and corresponding to the views expressed by the above-mentioned authors, and many others, such as Zarzecki (2012) and Szczepaniuk and Kucharzyk (2016). Hajek (2010) referred to the positive impact of forest management on *B. viridis* population – in the form of microhabitat supply (that is, stumps) and the reduction of competition through substrate shattering. Unquestionably, there is no doubt that forest management in the areas of *B. viridis* occurrence should be constrained in order to ensure the appropriate tree stand structure and continuity of deadwood existence, both in spatial and temporal perspective. The presented results suggest that broadly understood forest management, consisting not only of cutting down trees, could be a tool for active protection of *B. viridis*. However, the protection to be effective, it has to be based on sound knowledge; thus, further research on the ecology of this species is necessary.

Conflict of interest

The authors declare no potential conflicts.

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References

- Atherton I., Bosanquet S., Lawley M. (red.) 2010. Mosses and Liverworts of Britain and Ireland: A Field Guide. British Bryological Society, Plymouth, 337. ISBN 9780956131010.
- Chachuła P., Vončina G. 2010. The discovery of *Buxbaumia viridis* (Bryophyta, Buxbaumiaceae) in the Bieszczady National Park. *Roczniki Bieszczadzkie* 18: 419–423.
- Cieśliński S., Czyżewska K., Faliński J.B., Klama H., Mułenko W., Żarnowiec J. 1996. Relikty lasu puszczańskiego. Zjawiska reliktowe. (Wyniki badań w Projekcie CRYPTO na stałej powierzchni BSG: V-100; BPN; oddz. 256). *Phytocoenosis* 8 (N.S.), *Seminarium Geobotanicum* 4: 47–64.
- Czerwiński A. 1968. Baza produkcji leśnej Puszczy. w: Faliński J. B. (red.). *Park Narodowy w Puszczy Białowiejskiej*. PWRiL. Warszawa, 175–198.
- Dyrektywa 1992. Dyrektywa Rady 92/43/EWG z dnia 21 maja 1992 r. w sprawie ochrony siedlisk przyrodniczych oraz dzikiej fauny i flory.
- Fudali E., Zubel R., Stebel A., Rusińska A., Górski P., Vončina G., Rosadziński S., Cykowska-Marzencka B., Staniaszek-Kik M., Wiercholska S., Wolski G. J., Wojterska M., Wilhelm M., Paciorek T., Piwowski B. 2015. Contribution to the bryoflora of the Roztocze National Park (SE Poland) – Bryophytes of the Świerszcz river valley. *Steciana* 19(1): 39–54. DOI 10.12657/steciana.019.006.
- Hajek B. 2008. Charakterystyka współczesnych stanowisk mchu *Buxbaumia viridis* na Wysoczyźnie Elbląskiej (Polska północna). *Parki Narodowe i Rezerваты Przyrody* 27 (4): 27–34.
- Hajek B. 2010. Rozmieszczenie, wymagania środowiskowe oraz fenologia rzadkiego mchu *Buxbaumia viridis* (Moug. ex Lam. & DC.) Brid. ex Moug. & Nestl. w Trójmiejskim Parku Krajo-
brazowym. *Acta Botanica Cassubica* 7–9: 161–175.
- Hajek B. 2012. Nowe stanowisko rzadkiego mchu *Buxbaumia viridis* (Moug. ex Lam. & DC.) Brid. Ex Moug. & Nestl. (Bryophyta, Buxbaumiaceae) na Pomorzu Gdańskim. *Acta Botanica Cassubica* 11: 207–211.
- Kozik J., Vončina G. 2012. Odkrycie bezlistu okrywowego *Buxbaumia viridis* (Bryophyta, Buxbaumiaceae) w Beskidzie Niskim (Karpaty Zachodnie). *Roczniki Bieszczadzkie* 20: 378–383.
- Mueller-Dombois D., Ellenberg H. 1974. Aims and method of vegetation ecology. John Wiley & Sons, Inc. New York, 547. ISBN 0471622907.
- Ochyra R., Żarnowiec J., Bednarek-Ochyra H. 2003. Census catalogue of Polish mosses. Institute of Botany, Polish Academy of Sciences, Kraków, 372. ISBN 838544484X.
- Rozporządzenie 2014. Rozporządzenie Ministra Środowiska z dnia 9 października 2014 r. w sprawie ochrony gatunkowej roślin. Dz.U. 2014 poz. 1409.
- Schumacker R., Martiny P. 1995. Threatened bryophytes in Europe including Macronesia, w: Red data book of European bryophytes. Part 2. European Committee for Conservation Bryophytes, Trondheim, 31–193. ISBN 8299364507.
- Sokołowski A.W. 1996. Szata roślinna Rezerwatu im. Władysława Szafera w Puszczy Białowiejskiej. *Ochrona Przyrody* 53: 37–86.
- Stebel A. 2004. *Buxbaumia viridis* – bezlist okrywowy, w: Sudnik-Wójcikowska B., Werblan-Jakubiec H. (red). *Poradniki ochrony siedlisk i gatunków Natura 2000 – podręcznik metodyczny*. T. 9. Gatunki roślin. Ministerstwo Środowiska, Warszawa, 29–32. 228. ISBN 8386564431.
- Stebel A., Rosadziński S., Górski P., Fojcik B., Rusińska A., Vončina G., Szczepański M., Wilhelm M., Fudali E., Paciorek T., Staniszek-Kik M., Zubel R., Piwowski B., Wolski G. J., Salachna A., Smolińska D., Pierścińska A. 2013. Contribution to the bryoflora of the Świętokrzyski National Park (Central Poland). *Steciana* 17: 77–84.
- Szafran B. 1957. *Mchy (Musci)*. PWN. Warszawa, 449.
- Szczepaniuk A., Kucharzyk J. 2016. New occurrence of rare protected moss species *Buxbaumia viridis* (Bryopsida, Buxbaumiaceae) in the Białowieża Forest. *Steciana* 20(2): 93–96. DOI 10.12657/steciana.020.011.
- Szmajda P., Bednarek-Ochyra H., Ochyra R. 1991. M. 639. *Buxbaumia viridis* (DC.) Moug. & Nestl. w: Ochyra R., Szmajda P. (red.). *Atlas of the geographical distribution of spore plants in Poland, Ser. V. Mosses (Musci)* 7.W. Szafer Institute of Botany of the Polish Academy of Sciences, Adam Mickiewicz University, Kraków – Poznań: 47–52. ISBN 832320330X.
- Vončina G. 2012. Bezlist okrywowy *Buxbaumia viridis*, w: Perzanowska J (red.). *Monitoring gatunków roślin*. Przewodnik metodyczny 2: 40–52. GIOŚ, Warszawa, 342. ISBN 9788361227809.
- Vončina G., Chachuła P. 2012. Aktualne występowanie bezlistu okrywowego *Buxbaumia viridis* (Buxbaumiaceae, Bryophyta) w Pienińskim Parku Narodowym. *Pieniny – Przyroda i Człowiek* 12: 81–86.
- Zarzecki R. 2012. Nowe stanowisko *Buxbaumia viridis* (Buxbaumiaceae, Bryophyta) w południowo-wschodniej Polsce. *Fragmenta Floristica et Geobotanica Polonica* 19(2): 561–564.
- Zielonka T. 2006. When does dead wood turn into a substrate for spruce replacement? *Journal of Vegetation Science* 17: 739–746. DOI 10.1111/j.1654-1103.2006.tb02497.x.
- Żarnowiec J., Stebel A., Ochyra R. 2004. Threatened moss species in the Polish Carpathians in the light of a new Red-list of mosses in Poland, w: Stebel A., Ochyra R. (red.). *Bryological Studies in the Western Carpathians*. Sorus, Poznań, 9–28.

Authors' contribution

R.G. (50%), A.S. (50%) – concept, field data collection, literature review, manuscript writing/editing,