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SHORT COMMUNICATION

Occurrence of *Trichocolea tomentella* (Ehrh.) Dumort. (Marchantiophyta, Trichocoleaceae) in the Polish Carpathians: distribution, habitat preferences, current threats, and recommendations

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Abstract

This paper describes the vertical and horizontal distribution, habitat preferences, threats, and conservation status of *Trichocolea tomentella* in the Polish Carpathians based on the analyses of 138 localities. The species prefers wetland habitats, mostly within forests, such as areas in the vicinity of springs (34% stands), stream banks (32%), wet parts of the forest floor (20%), and mountain bogs (16%). As a consequence of the decrease in the areas of these habitat types, localities of *T. tomentella* are threatened with extinction. Therefore, according to the IUCN standards, this species should be placed in the near threatened (NT) category in the Polish Carpathians.

Keywords

Central Europe; distribution; habitat preferences; liverworts; threats; wetlands

Introduction

Trichocolea tomentella is large, up to 10 cm long leafy liverwort which is relatively easy to identify even by a nonbryologist. It has a pinnate branched stem and leaves divided into narrow, filiform, digitate lobes. On the dorsal side of the stem, numerous paraphyllia are present. The characteristic feature of this liverwort is its distinctive light green color. The species has a wide geographical range: it is widespread in Europe, temperate and tropical Asia, North and South America, and the Pacific Islands. In Europe, it is distributed in the suboceanic mountain regions [1,2]. In Poland, habitats of *Trichocolea tomentella* range from lowlands to the lower forest zone in the mountains, with a majority of suitable habitats situated in the northern part of Poland. It is much less frequent in the mountains where it grows in the foothills and in the lower part of the lower forest zone [3]. Currently, *Trichocolea tomentella* is not considered as an endangered species in Poland [it is in the least concern (LC) category] [4], but it is a partially protected species [5] because of its potential to be used for commercial purposes. In the Polish part of the Carpathians, the species occurs in almost all mountain ranges, but on rather dispersed sites. Its distribution and habitat preferences as well as forms of anthropopressure present in this part of Poland indicate that this species should be considered to be near threatened in these areas. The aims of this work were (i) to analyze the current distribution of *T. tomentella* in the Polish part of the Carpathians, (ii) to provide information concerning its habitat preferences, and (iii) to indicate current threats and recommendations for the conservation of this species.

Material and methods

Study area

The investigated area is a part of the Carpathians located in the southern and southeastern part of Poland. The Polish Carpathians occupy an area of about 20,000 km², which is slightly more than 6% of the total country area. This area spreads along 300 km in the eastwest direction and along 100 km in the northsouth direction, and it belongs to two geographical provinces, the Western and Eastern Carpathians [6].

Data collection and analysis

The occurrence of the species in the Carpathians was analyzed based on data compiled mostly from 155 revised herbarium specimens which are deposited in the following herbaria: LBL (18 specimens), KRA (14), KRAM (20), POZW (60), SOSN (30), WA (four), MGS (three), and in the private herbarium of H. Klama (six). These data provided information on 121 sites (88%) of *T. tomentella* in the study area. Some of these records (54 sites) have already been published. Exceptionally, data from bryological research not confirmed by the herbarium specimens were also used (17 sites).

Horizontal distribution was presented on a map using the ATMOS grid square system [7]. Vertical arrangement was analyzed for 100-m belts, which were based on 102 available records. The habitats of 122 locations were analyzed in order to identify the type of substrates, plant communities, and humidity level preferred by the studied species. The level of threat to the species was determined according to the categories and criteria defined by IUCN [4,8].

Results

Distribution

To date, *Trichocolea tomentella* is known to occur in 138 sites located in 23 mesoregions of the Polish Carpathians. Its occurrence was more frequent in the western part of the study area, particularly in the following mesoregions: the Podtatrzański Trench (Rów Podtatrzański; 26 sites), Żywiecki Beskids (Beskid Żywiecki; 23 sites), Silesian Beskids (Beskid Śląski; 15 sites), Island Beskids (Beskid Wyspowy; 14 sites), and Beskid Sadecki (Beskid Sądecki; 11 sites). In the other mesoregions, there were only a few stations (Appendix S1). Most of the analyzed sites (45%) were recorded after 2000, which was probably a result of the intensification of bryological research in this period and does not directly reflect the dynamic geographical distribution tendencies of this species.

The sites of *Trichocolea tomentella* were located in 58 ATMOS squares. In more than 85% of them, the species was growing on only one to three sites. The largest number of sites (28) was located in square GE 50 which included the eastern part of the Rów Podtatrzański and the northern parts of the Eastern Tatras (Fig. 1, Appendix S1).

Over 95% of the analyzed records were located below 1,000 m a.s.l., and more than 75% were in the range from 600 to 999 m a.s.l. (Fig. 2). It is worth noting that less than 9% of the stations were located below 500 m a.s.l.

Habitats

Trichocolea tomentella was found growing in forests in the vicinity of springs (41 stands), stream banks (39), wet parts of the forest floor (25), and in mountains bogs (19) (Fig. 3). It most frequently occurred on highly hydrated substrates, on mineral soil, on the humus and peat though it can also grow on stones and decaying branches in springs, seepages, and flushes, as well as on the banks of watercourses (Fig. 4). Some authors of the species records state that this species is most frequent in patches of *Abietetum polonicum* (Dziub. 1928) Br.-Bl. et Vlieg. 1939, *Abieti-Piceetum montanum*

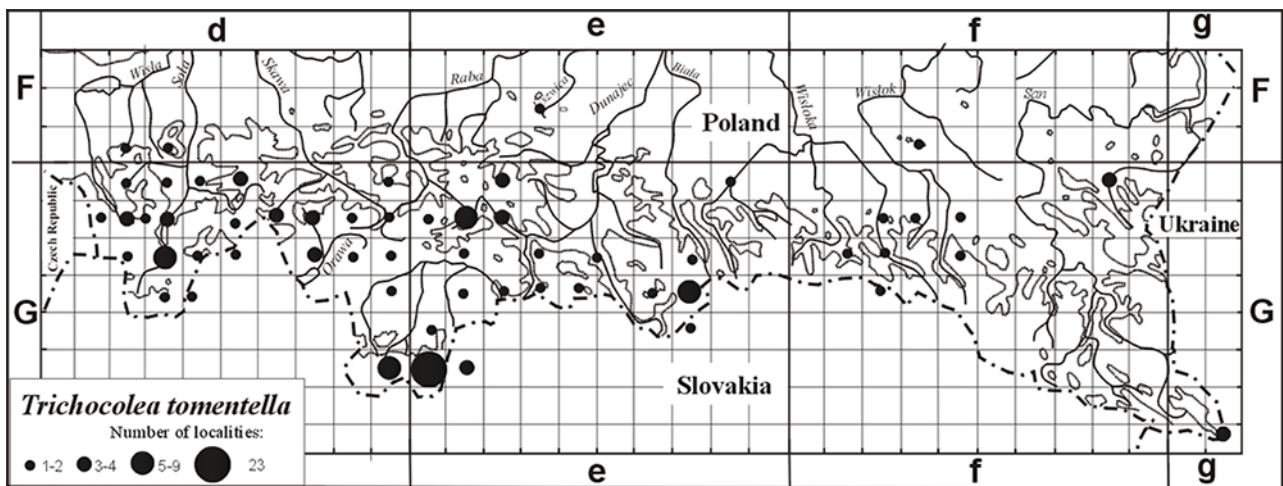


Fig. 1 Geographical distribution of *Trichocolea tomentella* in the Polish part of the Carpathians.

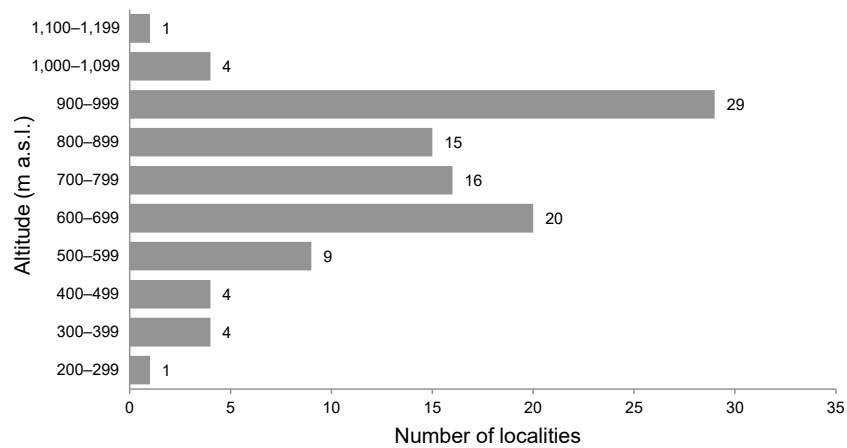


Fig. 2 Vertical distribution of *Trichocolea tomentella* at 100-m intervals.

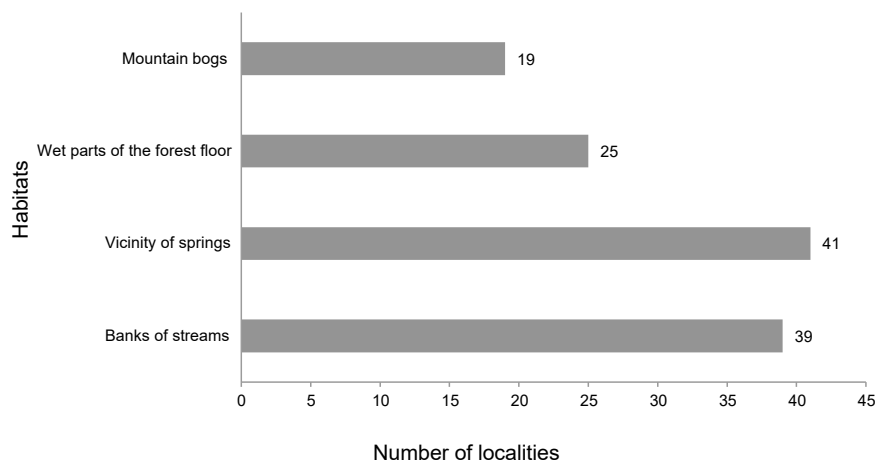


Fig. 3 Habitat preferences of *Trichocolea tomentella*.



Fig. 4 Habitat of *Trichocolea tomentella*.

Szaf., Pawł. et Kulcz. 1923 em. J. Mat. 1978, *Bazzanio-Piceetum* Br.-Bl. et Siss. 1939, and *Caltho laetae-Alnetum* (Zarz. 1963) Stuchlik 1968. Among nonforest communities, it frequently occurs in *Valeriano-Caricetum flavae* Pawł. (1949 n.n.) 1960, *Caricetum remotae* (Kästner 1941) Schwickerath 1944, and tall herb communities of *Adenostylin alliariae* Br.-Bl. 1925.

Threats and protection

Changes in water conditions and loss of habitats that are caused by drainage melioration, change of land use, and destruction of stream valleys are some factors that pose direct threats to the occurrence of this species. The scale of these changes in the foothills and lower parts of the lower Polish Carpathians are quite significant [4,9,10]. Therefore, it can be predicted that in the near future, the area of habitats preferred by *Trichocolea tomentella* will decrease and the quality of these habitats will deteriorate. In the Polish Carpathians, *T. tomentella* was recorded in 58 ATMOS squares of 100 km² (Fig. 1). The reference grid for calculating an occupied area (AOO) consisted of squares with an area of 4 km² [11]. After taking this correction into account, the total occupied area (AOO) of *Trichocolea tomentella* was 408 km². This means that according to the IUCN categories and criteria of species threats, this species should be placed in the near threatened category [B2b(iii)].

Summary and discussion

Trichocolea tomentella has a clustered pattern of distribution in the Polish Carpathians. In the foothills, it is a very rare species, which may be a result of this area being poorly explored. However, it should be noted that this part of the mountains is the most urbanized and transformed part, which leaves only a small number of suitable habitats for the studied species. In addition, this liverwort is very rare in mesoregions such as the Beskid Mały Mts, Gorce Mts, Beskid Niski Mts, and Bieszczady Zachodnie Mts. Even in the regions of the Carpathians with more recorded localities, this species cannot be considered as frequent. For example, in the western part of the Beskid Żywiecki Mts where *T. tomentella* was recorded on 11 sites, most records were from the northeastern slopes of Rachowiec Mt in the vicinity of Butorza Nature Reserve. This clustered pattern of distribution may be the result of the method of reproduction of this species. *Trichocolea tomentella* does not form spores, gemmae, or other special diaspores, but rather spreads by fragmentation. This study clearly indicated that *Trichocolea tomentella* is a spring liverwort, a hygrophyte that grows in moist and wet habitats with a permanent water flow and moderate light intensity. These results are consistent with Ellenberg's [12] and Dierssen's [13] data, according to which *Trichocolea tomentella* is an acidophilic, subneutrophilic, moderately shade-loving, and hygrophilous liverwort. In Poland, *Trichocolea tomentella* is considered to be a species characteristic of *Alnetea glutinosae* Br.-Bl. et R. Tx. 1943 [14]. However, the conducted analysis indicated that the phytocoenotic range of this species is much wider (Appendix S1). The occurrence of *Trichocolea tomentella* in the Polish part of the Carpathians almost entirely overlaps with biochores occupied by plant communities that grow on three types of natural habitats, all of which require protection under the Natura 2000 network (codes: 91D0, 91E0, 91P0) [15]. *Trichocolea tomentella* is not considered as a threatened species in Poland; however, in some southern regions of the country it is recommended that it should be [10]. The level of threat to this species in the countries through which the Carpathian chain extends is different, i.e., in Serbia and Hungary it is included in the EN category, while in other countries it is not treated as threatened [16].

Trichocolea tomentella is sensitive to anthropopressure. According to Dierssen [13], it belongs to a group of ahemerobic-oligohemerobic species which can tolerate only a small amount of human activity in their habitats. Therefore, the biggest threat for its survival is intensive forest management, especially the dying off of spruce that has been observed in the recent years [17,18] and has resulted in the forest floor being exposed as well as caused adverse changes in habitat conditions. On the other hand, this species has not spread into habitats that are under the influence of intensive forest management, and this is probably because these liverworts do not reproduce generatively [19].

As a consequence of the biology of its reproduction, its habitat requirements, and the ease of identifying this liverwort, *Trichocolea tomentella* can be a good bioindicator of changes in the water relations in mountains that are, among others, caused by climate change and human activity. Therefore, future research should consider monitoring the state of the *Trichocolea tomentella* populations on selected permanent study plots. In order to protect the habitats and localities of *Trichocolea tomentella*, it is necessary to avoid cutting forests down, draining wet and boggy areas in forests, changing the water conditions in stream valleys, and regulating and building stream beds. Such activities should be considered by anyone responsible for environmental management in the mountains.

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Supplementary material

The following supplementary material for this article is available at <http://pbsociety.org.pl/journals/index.php/asbp/rt/suppFiles/asbp.3631/0>:

Appendix S1 List of localities of *Trichocolea tomentella* in the Polish Carpathians.

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