

The streams of the Western Carpathians – a hotspot of freshwater lichens diversity in Poland

The thesis presents the results of lichenological research conducted in the years 2012–2016 based on own fieldwork carried out in mountain streams in the Polish Western Carpathians, revision of herbarium materials and published data on lichen species in freshwater habitats in the study area. Field work was performed on 98 research plots divided into 3 zones related to the duration of immersion (in total 294 sampling sites were investigated).

As the result of the work 93 freshwater lichen species were found (90 based on own field work and/or revision of herbarium material), including 55 aquatic species (Table 2). For all species detailed descriptions of morphological and anatomical characters, information on their habitat, occurrence in the study area, worldwide and country distribution, and short taxonomic discussion are given. A key for species identification is also provided.

In the course of present lichenological study, 7 species new to Poland were found: *Bryobilimbia ahlesii*, *Rhizocarpon sublavatum*, *Thelidium circumspersellum*, *T. klementii*, *T. pluvium*, *T. rehmi* and *Verrucaria devensis*. One species, *Verrucaria acrotella* has not been reported from the study area before. In addition, 36 new species were recorded in particular mountain ranges, including 26 aquatic species.

The streams of the Polish Western Carpathians are characterized by a large species diversity in various mountain ranges (Table 2, 3). The richest lichen biota was observed in the streams of the Tatra Mts, where 76 species were found, representing more than 80% of the total number of freshwater lichens known from the Western Carpathians. In the Beskid Mountains species diversity in the streams is maintained at a similar level, in the range of 35–45 species (Figure 6). The two mountain ranges have distinguished themselves with more species, the Beskid Sądecki Mts (60) and the Beskid Żywiecki Mts (57). It is probably related to the fact that the first range was chosen as the model area with more detailed field works were carried out and the Beskid Żywiecki Mts where two additional climatic and vegetation zones are present. In the Carpathian foothills 36 taxa were noted.

The frequency analysis of lichens shows that very rare species – 37 (40%) and rare species – 32 (35%) dominate in the study area. Frequent lichens in the Polish Western Carpathians are the poorest group, of only 4 species (slightly over 4%; Figure 7, 8). Of all lichens noted in the study area, 34 (c. 37%) are placed on the red list of the lichens in Poland (Cieśliński et al. 2006).

Assemblages of freshwater lichens are impacted by many ecological factors such as the type of the substrate, duration and frequency of immersion, sunlight, silting degree and physicochemical parameters of water. In the case of Carpathian streams, the presence of stable substrate and the duration of the inundation seem to be the most important factors for freshwater lichens occurrence. The duration of immersion has also an influence on the species distribution (Table 5). The submerged zone was the least diverse both in the terms of the number of species and represented families. The only species found here exclusively in the submerged zone were: *Ionaspis lacustris*, *Sporodictyon cruentum*, *Staurothele fissa*, *Thelidium submethorium*, *Verrucaria devensis* and *V. pachyderma*. The splash zone provides a habitat transitional between the submerged and riparian zone. Lichens existing in this zone are constantly exposed to frequent changes between periods of inundation and desiccation. In the splash zone both species found in submerged zone as well as those occurring in riparian zone were found. However, typical species for splash zone were, e.g. *Bacidina inundata*, *Gyalidea rivularis*, *Thelidium fontigenum*, *T. pluvium*, *Verrucaria humida* and *V. sublobulata*. The most diverse group of lichens was associated with the riparian zone. Many lichens found in this zone are terrestrial lichens, commonly found in non-freshwater habitats. They are considered to be rare in aquatic and semi-aquatic habitats but frequent in terrestrial habitats.

The obtained results concerning the species diversity of the study area confirm that the streams of the Polish Western Carpathians are a hotspot of freshwater lichens diversity in Poland.