

**Zeitschrift:** Cryptogamica Helvetica  
**Herausgeber:** Schweizerische Vereinigung für Bryologie und Lichenologie Bryolich  
**Band:** 18 (1995)  
  
**Artikel:** Measures to protect bryophytes in the Tatra Mountains (Slovakia)  
**Autor:** Šoltés, Rudolf  
**DOI:** <https://doi.org/10.5169/seals-821140>

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## MEASURES TO PROTECT BRYOPHYTES IN THE TATRA MOUNTAINS (SLOVAKIA)

RUDOLF ŠOLTÉS

Research Station of the Tatra National Park, SQ-059 60 Tatranská Lomnica, Slovakia

**SUMMARY** — *The Bryophyte flora of the Tatra Mountains (Slovakia), the highest European mountains between the Caucasus and the Alps, has been described extensively since the 60s of last century. Of the approximately 700 species known from the Tatra National Park, a number of species have declined or have even become extinct due to air pollution, habitat destruction, natural succession or modern forestry. 83 taxa are listed in the proposed Red List of which 15 taxa are classified as endangered or vulnerable on a European scale. Four habitat types important for bryophytes (peatland habitats, freshwater habitats, epiphytic moss vegetation and epixylic bryophytes) and the threats affecting them are briefly described. Measures and recommendations for bryophyte protection in the Tatra National Park are presented. They include mapping of bryophyte species distribution with special reference to epiphytes and their phorophytes, monitoring peatlands and suggestions for individual forestry practice. The difficulties and peculiarities of bryophyte conservation are discussed.*

**KEYWORDS** — *Tatra Mountains, vulnerable habitats, bryophyte conservation, national park*

**ZUSAMMENFASSUNG** — *Massnahmen zum Schutz von Moosen in der Tatra (Slowakei)*

*Die Moosflora der Tatra (Slowakei), des höchsten europäischen Gebirges zwischen dem Kaukasus und den Alpen, wurde seit den Sechzigerjahren des letzten Jahrhunderts intensiv erforscht. Von den ca. 700 Arten des Tatra-Nationalparks sind einige wegen Luftverschmutzung, Lebensraum-Zerstörung, natürlicher Sukzession oder der modernen Forstwirtschaft zurückgegangen oder sogar erloschen. 83 Taxa sind in der vorgeschlagenen Roten Liste aufgeführt; 15 davon sind europaweit als bedroht (E) oder gefährdet (V) eingestuft. Vier Lebensraumtypen, die für Moose wichtig sind (Torfmoore, Gewässer, epiphytische Vegetation und totes Holz), und die Gefahren, die ihnen drohen, werden kurz beschrieben. Massnahmen und Empfehlungen für den Mooschutz im Tatra-Nationalpark werden vorgestellt. Sie umfassen die Kartierung der Moosarten mit besonderer Berücksichtigung der Epiphyten und ihrer Trägerpflanzen, Überwachung der Moore und Anregungen für eine von Fall zu Fall angepasste forstliche Praxis. Die Schwierigkeiten und Besonderheiten des Mooschutzes werden diskutiert.*

### Introduction

The Tatra Mountains (Slovakia) are the highest European mountains between the Caucasus and the Alps. The bryophyte flora of the Tatra Mountains has been described extensively from the 60s of the last century, so we have extensive material for comparing the present status with that of the last century. The bryoflora in the Tatra National Park is better known than the floras of any other Slovak Mountains and includes approximately 700 species. Until recently, conservation of bryophytes has received in Slovakia less attention than conservation of vascular plants. The reasons are their inconspicuous appearance and insignificance from an economic point of view, and the lack of lower plant specialists. In the Tatra Mountains, 83 taxa are listed in the proposed Red List (Kyselová & al. 1994), 15 taxa are classified endangered or vulnerable on a European scale. Several Tatra Mountains bryophytes have become rare or even extinct due to air pollution, habitat destruction, natural succession or modern forestry and agricultural practices. The Administration of the Tatra National Park understands that their extinction means a loss of biodiversity and that each species has an intrinsic value. Nomenclature for mosses follows Corley & al. (1981), for hepatics Duda & Váňa (1974) and for higher plants Červenka & al. (1986).

## Some more vulnerable habitats

### Peatland habitats

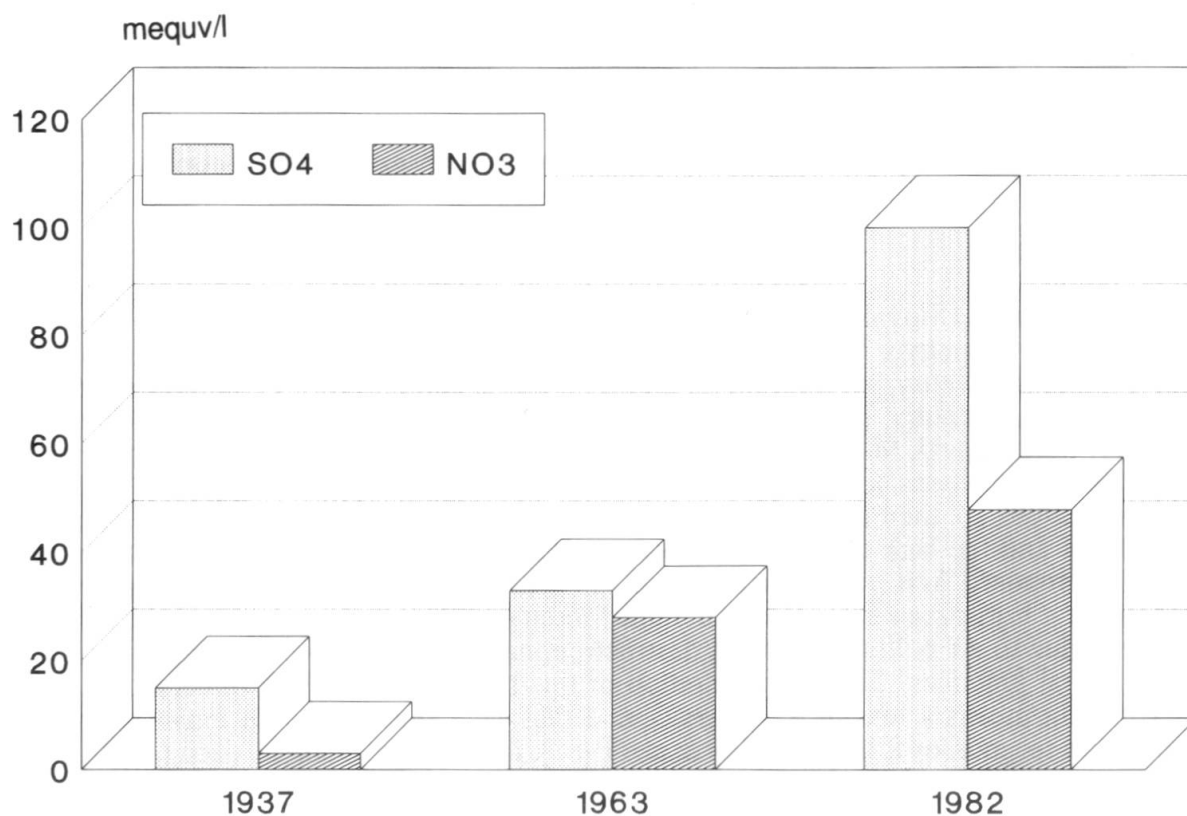
These locations have become suitable habitats for many endangered and precious species of vascular plants and mosses and their communities. Peatland habitats include raised bogs, rich fens (enriched by base compounds) and intermediate fens, together amounting to 227 hectares and therefore their protection needs to be a matter of concern. At present they are endangered mainly by air pollution and groundwater extraction for drinking water. Some peatland habitats are endangered by natural tree seeding and overgrowing. Many peatland habitats were in the past turned into fields by land reclamation and other agricultural practices, and others have been considerably reduced by construction of infrastructure, straightening of river beds, turf cutting etc. Among moss species so endangered are *Paludella squarrosa*, *Hypnum pratense* and *Sphagnum platyphyllum*.

Peatland habitats represent a valuable natural heritage for the Tatra National Park and adequate protection of them is an essential part of the Park's function.

### Freshwater habitats

The main features of this ecosystem are generally low diversity and high vulnerability due to acid rain and anthropogenic contamination. We have no information on the pH levels of lakes and streams some decades ago, but we know the concentration of some anions in the years 1937 and 1963. The concentration of bicarbonate has decreased and the concentrations of sulphate and nitrate have increased several times within 45 years (Fig. 1). From these data it follows that the process of acidification of the waters of the High Tatra Mountains has already begun (Stuchlík & al. 1985).

Still water is the habitat of some critically endangered vascular plant species (*Juncus castaneus*, *Carex limosa*) and some rare bryophyte species, e.g., *Scapania paludosa*.



**FIGURE 1.** Concentrations of sulphate and nitrate in the Tatra waters in the years 1937, 1963 and 1982 (From Stuchlík & al. 1985).

Running water is the habitat of some rare higher plant species (*Epilobium anagallidifolium*, *Cardamine opizii*). Some rare moss species are restricted to this habitat, e.g., *Fontinalis antipyretica* and *Hydrogrimmia mollis*. Rapid streams are the habitat of the community *Hygrohypnetum dilatati*.

### Epiphytic moss vegetation

Special conservation effort is rarely given to epiphytic moss species. The reason is a lack of experts.

The bark of coniferous as well as of broadleaved trees, is a convenient substratum for some bryophytes, which are rapidly declining on a European scale, e.g., *Frullania dilatata* and *Orthotrichum lyellii*. Some species in the Tatra Mountains must now be considered to be extinct, e.g., *Ulota rehmanii*. This bryophyte group is under threat from air pollution and from acid rain. Some important epiphytes are restricted to deep, constantly humid and shaded forest stands preserved from immission of pollutants and strong winds. Important phorophytes are some trees managed as parkland, or as trees in avenues, e.g., *Fraxinus excelsior*, *Tilia cordata*, *Populus tremula*, *Populus alba*, *Ulmus glabra*, *Betula pendula*, *Sorbus aucuparia*, and *Acer pseudoplatanus*.

### Epixylic bryophytes

Modern forestry management in the Tatra National Park has caused microclimatic changes. These are not favourable for epixylic bryophytes requiring decaying wood and a constantly humid microclimate (Laaka 1992). The Forest Management Plan, which is obligatory in the Tatra National Park and is set for ten years, does not allow leaving decaying logs on the forest floor except where the relief is very irregular. The removal of dead and fallen trees from the forest reduces the amount of available substrate for epixylic bryophytes (Söderström 1988). Isolated populations occurring at few sites have reduced possibilities of colonizing new areas (Laaka 1992, Ehrlich 1990). The result of these modern forestry practices in the Tatra Mountains is the decline of epixylic bryophyte biodiversity. Special attention in the Tatra Mountains is needed to be paid to species like *Buxbaumia viridis*, *Nowellia curvifolia*, *Calypogeia suecica* and *Scapania massalongi*.

### Measures to protect bryophytes

The following points and recommendations are made directly in relation to the conservation of bryophytes:

- a) The Biodiversity Programme currently running at Tatra National Park is the first step to find out which species are present and to map their distribution. The data are stored electronically in the TANAP database. All visiting bryologists are encouraged to complete the species data sheets.
- b) The peatland areas are being currently visited and the locations influenced in the past by drainage are being monitored. Fortunately, we have found till now that these old field drains are inefficient. When colonization by invading trees or shrubs is observed, they are removed.
- c) The Tatra Mountains are extremely well covered by trees, but there is clearly going to be a conflict of interest between forestry and the conservationists of bryophytes as to how these forests should be managed. Liaison between foresters and conservationists is vital. Conservationists must point out the ecological demands of the various moss species, and liaise with foresters to find the most suitable compromise. Before conservationists can advise foresters they have to know a good deal about the autecology of the species they wish to protect. Very few autoecological studies have so far been made on endangered Tatra bryophyte species. It is vital that bryologists implement knowledge gained from autecological research carried out in the Tatra Mountains. Some short-term conservation interests of bryophytes may be implemented in the meantime. There is a general need

for many more logs to be left on the forest floor so that the decaying wood will be colonized by liverworts. Suggestions for individual forestry measures are being made and will be passed to the Forest Management of the Tatra National Park in order that ordinary forest practices may be omitted in some areas.

- d) All phorophytes of high biological value in the territory of the Tatra Mountains and their wide surroundings are mapped, the epiphyte species are being listed. The data are being stored electronically into the TANAP database and passed to the District's Environmental Agencies situated close to the National Park. This should ensure that phorophytes of high biological value are kept away from any potential damage from environmental or human impact and will have a conservation-orientated management. This idea has already been accepted by the District's Environmental Agency in the town of Poprad which is the most important because its district includes the largest zone of the Tatra Biosphere Reserve.

Moreover, we are looking for protected, humid, shady locations in order to create reserves for species especially sensitive to air pollution as suggested by Hallingbäck (1992).

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