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The Brissago Islands in the Lake Maggiore – A hotspot for red-listed bryophytes and re-discovery of *Entodon cladorrhizans* in Switzerland

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Abstract: A floristic survey of the Brissago Islands (Isole di Brissago, Canton Ticino, Switzerland) held in 2023 and 2024 revealed a remarkable diversity of bryophytes, and most notably an unexpected high number of threatened species. In total, we observed 146 taxa of which 56 were documented for the first time on the islands, compared to earlier findings primarily based on an inventory conducted in 1986 and 1987. Fourteen of the species recorded are red-listed in Switzerland, including *Brachythecium capillaceum*, *Bryum gemmiparum*, *Fissidens rivularis* and *Scorpiurium deflexifolium*, and eight are near threatened. The most remarkable discovery was that of *Entodon cladorrhizans*. This species is treated as potentially extinct in the current national red list, because it has not been observed in over 100 years, and targeted searches at historical sites had been unsuccessful. We also present a contemporary record of *Trichostomum littorale* in Switzerland, previously classified within the broader concept of *T. brachydontium*. We suggest that the rich bryophyte flora on the Islands is fostered by a high diversity of semi-natural as well as anthropogenic habitats offering a high variability of microenvironments.

Keywords: biodiversity, Canton Ticino, liverworts, mosses, red list

Le Isole di Brissago nel Lago Maggiore – Un hotspot per briofite della lista rossa e riscoperta di *Entodon cladorrhizans* in Svizzera

RIASSUNTO ESTESO

Introduzione: Dalla loro apertura nel 1950, le Isole di Brissago sono state percorse da migliaia di visitatori attratti, oltre che dalla loro posizione privilegiata, dallo storico Giardino Botanico. In gran parte inosservate sono state le briofite, che tuttavia prosperano fra le piante coltivate, sui muri, le rocce e presso le rive. Il primo importante rilevamento briologico fu eseguito da Max Leimgruber 35 anni fa (Leimgruber 1988). Il presente contributo presenta i risultati di un secondo inventario della flora briofitica eseguito fra il 2023 e il 2024 con il sostegno del Cantone Ticino.

Materiali e metodi: Le Isole di Brissago si trovano a sud-ovest del Cantone Ticino e occupano un'estensione di 3.38 ettari distribuiti fra l'Isola di San Pancrazio, la più grande delle isole, e l'Isola di Sant'Apollinare, non accessibile al pubblico. Le Isole, che godono di un clima insubrico, si situano ad un'altitudine di 200 m s.l.m. Le Isole sono state oggetto di sopralluoghi per un totale di 3 giorni fra il 2023 e il 2024, cercando di percorrere ogni area accessibile con lo scopo di creare una lista di specie il più completa possibile. Il livello del lago, troppo elevato al momento dei sopralluoghi, non ha permesso di rilevare specie riparie pioniere. La nomenclatura e lo stato di minaccia sono coerenti con la nuova Lista Rossa delle briofite minacciate in Svizzera (Kiebacher et al. 2023). I campioni raccolti sono conservati principalmente nell'erbario del Museo cantonale di storia naturale di Lugano (LUG) e i dati sono stati trasmessi al centro nazionale Swissbryophytes. Per valutare se siano intercorsi cambiamenti nella flora briofitica nel corso degli anni, la lista attuale è stata comparata con i dati dell'inventario di Leimgruber e ad altri dati del centro dati Swissbryophytes.

Risultati: Complessivamente abbiamo catalogato 314 campioni appartenenti a 146 taxa diversi, di cui 11 epatiche e 135 muschi. Quattordici di queste specie sono elencate nella Lista Rossa delle briofite minacciate in Svizzera e otto sono potenzialmente minacciate. Dopo la revisione di alcuni campioni critici raccolti da Leimgruber e la loro relativa riassegnazione tassonomica, si è arrivati al considerevole numero di 169 taxa registrati fra il 1970 e il 2024, 58 dei quali rilevati per la prima volta nell'inventario attuale. Ventitré delle specie precedentemente registrate non sono state trovate nel 2023-24. Le specie minacciate comprendono, fra le altre, due specie in pericolo critico di estinzione (CR), *Entodon cladorrhizans* (Hedw.) Müll. Hal., ritrovata dopo più di un secolo dall'ultima osservazione in Svizzera, e *Scorpiurium deflexifolium* (Solms) M. Fleisch. & Loeske, oltre a tre specie in pericolo di estinzione (EN), *Fissidens rivularis* (Spruce) Schimp., *Bryum gemmiparum* De Not., *Brachythecium capillaceum* (F. Weber & D. Mohr) Giacom. Si riporta inoltre una segnalazione recente di *Trichostomum littorale* Mitt. in Svizzera, precedentemente classificata nel concetto più ampio di *T. brachydontium*.

Discussione: Con l'attuale presenza di almeno 146 taxa, le Isole di Brissago presentano una ricchezza di specie inaspettatamente elevata. Nei circa 3 ettari di superficie delle Isole è presente il 13% della flora briofitica Svizzera, che è pari a 1153 taxa (Kiebacher et al. 2023). Con un totale di 14 specie elencate nella Lista Rossa, e soprattutto con la presenza di *E. cladorrhizans* e *S. deflexifolium*, attualmente noti solo sulle Isole di Brissago, queste isole rivestono un significato particolare per la flora briofitica del Ticino e della Svizzera nel suo complesso. Diversi fattori sono probabilmente determinanti per l'elevata ricchezza di specie e la presenza di molte specie della Lista Rossa sulle Isole di Brissago. Da un lato, la vicinanza al lago crea un'elevata umidità, generalmente favorevole alla presenza delle briofite, dall'altra un'elevata diversità strutturale che si traduce in una grande varietà di microhabitat, caratterizzati in particolare da una diversità di substrati: suoli argillosi e sabbiosi, varie specie arboree, rocce silicee nonché substrati rocciosi calcarei (soprattutto vecchi muri) e legno morto. Probabilmente gioca un ruolo anche l'uso del suolo, meno intensivo rispetto alle aree rivierasche del Lago Maggiore. Il fattore geografico contribuisce probabilmente alla presenza di specie della Lista Rossa: alcune di queste specie sono comuni nella regione mediterranea, ma raggiungono il limite del loro areale settentrionale in Ticino e sono per questo classificate come minacciate in Svizzera a causa della loro circoscritta presenza: si tratta di *S. circinatum* (Bruch) M.Fleisch. & Loeske e *S. deflexifolium*, di *Grimmia lisae* De Not. e di *Lewinskya acuminata* (H.Philib.) F.Lara & al. A causa della diversa durata e dei diversi momenti dell'anno in cui sono state condotte le indagini precedenti e quelle attuali, non è possibile valutare in modo conclusivo il cambiamento effettivo nella flora briofitica sulla base dell'analisi dei dati. Le differenze maggiori sono probabilmente di natura metodologica; tuttavia, ci sono indicazioni di effettivi cambiamenti. Alcune delle specie del precedente inventario non hanno potuto essere ritrovate (per esempio *Plagiochila porelloides* (Torr. ex Nees) Lindenb., *Cynodontium polycarpon* (Hedw.) Schimp., *Sciuro-Hypnum reflexum* (Starke) Ignatov & Huttunen), ma ciò non significa che non siano più presenti. Analogamente, alcune specie trovate nell'attuale inventario erano verosimilmente già presenti allora ma non identificate perché tassonomicamente complesse (es. Orthotrichaceae). Un cambiamento probabilmente reale è invece rappresentato dall'avvento o aumento di specie mediterranee (*L. acuminata*, *S. circinatum* e *S. deflexifolium*) e da quelle oceaniche (*Orthotrichum tenellum* Bruch ex Brid. e *Dicranoweisia cirrata* (Hedw.) Lindb.).

Parole chiave: biodiversità, Cantone Ticino, epatiche, lista rossa, muschi

INTRODUCTION

The Brissago Islands are one of the most popular tourist destinations in the Locarno area. Since opening to the public in 1950, they are annually visited by thousands of visitors attracted by the picturesque location and the historical botanical garden. Largely unnoticed by visitors, various bryophytes thrive among the cultivated plants, on the walls and trees, the rocks, and in the pavement crevices of the visitor paths. About 35 years ago, Max Leimgruber first paid intensive attention to these organisms and compiled an initial inventory of the bryophyte flora of the Brissago Islands (Leimgruber 1988). Earlier, in 1970 Fintan Greter made a few collections and recorded *Scorpiurium deflexifolium* (Swissbryophytes 2004-2024). To this day, the Brissago Islands remain the only known location for this species in Switzerland. Later contributions came mainly from Edi Urmi, who visited the islands in 1995 and 2017 and observed *S. deflexifolium* on both islands. As part of an initiative sponsored by Canton Ticino to investigate the natural occurrences of various groups of organisms on the Islands of Brissago, we have created a second inventory of the bryophyte flora.

METHODS

The Brissago Islands in the Lake Maggiore are located in the southwest of Canton Ticino, just a kilometre from the Italian border, in an Insubrian climate and at an altitude of about 200 m a.s.l. The total area of 3.38 hectares is distributed between two islands, San Pancrazio and Sant'Apollinare, both formed from

silicate bedrock. San Pancrazio, the larger of the two islands, hosts a villa that is now used as an administrative building, hotel and restaurant, as well as a botanical garden dating back to the end of the nineteenth century. Sant'Apollinare is not accessible to the public and features a park-like stand of trees, predominantly consisting of native species. The habitats colonised by bryophytes include the parklands, masonry, flower beds, lawns, and various rocky outcrops, especially those exposed along the shores.

Field work lasted 3 non-consecutive days: on 24.-25.6.2023 and on 19.2.2024, whereby, Sant'Apollinare was visited for about 4 hours on 24.2.2023. Bryophytes were searched in all accessible areas with the main objective to create a species list as complete as possible for the two islands together. Due to time constraints, creating separate comprehensive lists for each island was of secondary priority. Because the lake water level was in the middle range on all days it was not possible to survey pioneer communities, as they develop on the shore during prolonged low water levels. If necessary for identification, we collected small samples and later identified them microscopically. Nomenclature and threat status follow the new Red List of Switzerland (Kiebacher et al. 2023), except for *Trichostomum brachydonium* s.l., for which the latest treatment by Ros et al. (2022) was used. Threat status at the European level is according to Hodgetts et al. (2019). Vouchers of collected specimens are stored at the herbarium of the Natural History Museum of Canton Ticino (LUG) and Edi Urmi's and Thomas Kiebacher's herbaria, and all records were submitted to the national data centre Swissbryophytes (www.swissbryophytes.ch).

To derive potential changes in the bryophyte flora over

time, the list of recorded taxa was compared to previous records by Leimgruber (1988) and data in the national database of Swissbryophytes (2004-2024). Besides few later records of Leimgruber, the Swissbryophyte data include four records by Fintan Greter from 1970-71, one record by Norbert Schnyder from 1988, and 20 records by Edi Urmi from 1995 and 2017. To confirm the identity of previously recorded species, specimens of *Hygroamblystegium tenax*, *Orthotrichum pumilum* and *Tortella nitida* collected by Leimgruber were reviewed in LUG.

RESULTS

We catalogued 314 observations belonging to 146 different taxa, 11 liverworts and 135 mosses (Appendix 1). On San Pancrazio we recorded 127 and on Sant'Apollinare 41 taxa. Fourteen of these taxa are red-listed in Switzerland and eight are near threatened (Tab. 1). The threatened species comprise two critically endangered taxa, *Entodon cladorrhizans* and *Scorpiurium deflexifolium*, and three endangered species (*Fissidens rivularis*, *Bryum gemmiparum*, *Brachythecium capillaceum*). At the European level, four of the species recorded on the islands are threatened, *Atrichum tenellum* (VU), *Orthotrichum microcarpum* (VU), *O. stellatum* (VU) and *Philonotis marchica* (EN). The revision of Leimgru-

ber's collections in LUG revealed that according to our expertise the specimens of *Hygroamblystegium tenax* belong to *Cratoneuron filicinum*, the specimen of *Orthotrichum pumilum* comprises a few shoots without sporophytes which belong to *O. tenellum*, and specimens of *Tortella nitida* match *T. fasciculata*. Considering these revisions, the total number of species recorded on the Brissago Islands between 1970 and 2024 comprises 169 taxa of which 58 were only observed in the current inventory. Twenty-three of the previously recorded taxa could not be found in 2023-24 (Tab. 2). When comparing only the two inventories (Leimgruber 1988 vs. the present survey), 66 species were newly recorded and 18 were no longer found.

DISCUSSION

With the current occurrence of at least 146 species, the Brissago Islands unexpectedly exhibit a high species richness. Compared to the total 1153 taxa in Switzerland (Kiebacher et al. 2023), it means that nearly 13% of the Swiss bryophyte diversity is present on a very small area (ca. 3 ha, i.e. 0.00000073% of Switzerland). With a total of 14 species listed in the Swiss Red List, four threatened at the European level, and especially with *Entodon cladorrhizans* and *Scorpiurium deflexifolium*

Table 1: List of threatened or near threatened bryophyte species on the Brissago Islands (Canton Ticino, Switzerland). Threat category according to the current Red List (RL; Kiebacher et al. 2023). CR (PE) Critically Endangered (Possibly Extinct), EN Endangered, VU Vulnerable, NT Near Threatened.

Species	RL	Years of record
<i>Anomobryum julaceum</i> (Schr. ex G. Gaertn. & al.) Schimp.	VU	2023
<i>Brachythecium capillaceum</i> (F. Weber & D. Mohr) Giacom.	EN	2023
<i>Bryum gemmiferum</i> R. Wilczek & Demaret	VU	2023
<i>Bryum gemmiparum</i> De Not.	EN	2023
<i>Campylopus pyriformis</i> (Schultz) Brid.	NT	2023
<i>Dialytrichia mucronata</i> (Brid.) Broth.	VU	1986, 2023
<i>Didymodon insulanus</i> (De Not.) M.O. Hill	NT	1986, 1987, 2023
<i>Entodon cladorrhizans</i> (Hedw.) Müll. Hal.	CR (PE)	2023
<i>Fissidens rivularis</i> (Spruce) Schimp.	EN	2023
<i>Grimmia lissae</i> De Not.	VU	2023
<i>Hygroamblystegium humile</i> (P. Beauv.) Vanderp. & al.	VU	1989
<i>Lewinskya acuminata</i> (H. Philib.) F. Lara & al.	NT	2023
<i>Microeurhynchium pumilum</i> (Wilson) Ignatov & Vanderp.	VU	2023
<i>Orthotrichum microcarpum</i> De Not.	NT	2023
<i>Orthotrichum stellatum</i> Brid.	VU	2023
<i>Philonotis marchica</i> (Hedw.) Brid.	VU	2023
<i>Riccia bifurca</i> Hoffm.	VU	2023
<i>Schistidium lancifolium</i> (Kindb.) H.H. Blom	VU	2023
<i>Sciuro-Hypnum flotowianum</i> (Sendtn.) Ignatov & Huttunen	NT	2023
<i>Scorpiurium circinatum</i> (Bruch) M. Fleisch. & Loeske	NT	1991, 2017, 2023
<i>Scorpiurium deflexifolium</i> (Solms) M. Fleisch. & Loeske	CR	1970, 1995, 2017, 2023
<i>Syntrichia fragilis</i> (Taylor) Ochyra	NT	2017, 2023
<i>Timmia anomala</i> (Bruch & Schimp.) Limpr.	NT	2023

currently known in Switzerland only on the Brissago Islands, these islands hold high significance for the bryophyte flora of Ticino, in particular, as well as for Switzerland and Europe, in general. However, it may astonish that some species are considered more endangered on the European Red List than on the national Red List (cf., Hodgetts et al. 2019; Kiebacher et al. 2023). For example, *Atrichum angustatum* is evaluated as endangered and *Orthotrichum microcarpum* as vulnerable on the European Red List, while in Switzerland they have been assessed as least concern and potentially endangered, respectively. This is because, for the assessment in Switzerland, new records were available that indicated a spread of these species.

In the following, we discuss the reasons for the high species richness on the Brissago Islands, address possible changes derived from the species lists of the two inventories, and present a selection of noteworthy species in more detail.

High species richness including many threatened species

Several decisive factors are expected to explain the high species richness and the presence of many red-listed species on the Brissago Islands. Firstly, the proximity to the lake creates high humidity, which is generally favourable for the occurrence of bryophyte species (e.g., Király et al. 2013). Furthermore, the islands exhibit many different habitats, particularly characterized by a diversity of substrates (as observed during our fieldwork): both clay and sandy soils, various tree species, silicate rocks as well as calcareous rock substrates (especially old walls and crevices) and deadwood. Both habitat and substrate diversity are well known to have positive effects on bryophyte species richness (e.g., Zechmeister & Moser, 2001; Fenton & Bergeron, 2008). Most likely, the ongoing mild land use compared to the heavily utilized and extensively rearranged shoreline areas of Lake Maggiore in recent decades also plays a significant role. Finally, a geographical factor contributes to the occurrence of red-listed species. Some of the threatened species are those more commonly found in the Mediterranean region (Dierssen 2001). These species (*S. circinatum* and *S. deflexifolium*, *Grimmia lisa*, and *Lewinskya acuminata*) reach the northern border of their main range in Ticino and are classified at risk of extinction in Switzerland due to their limited occurrences. The other red-listed species are threatened due to varied factors including small population size and habitat degradation (Kiebacher et al. 2023).

Changes of the flora over time and comparison with earlier records

Due to differing sampling intensity and timing between the previous and present surveys, results are not uncritically comparable; therefore, it is not convincingly possible to assume that observed losses and gains represent real changes in the bryophyte flora. The greatest differences are likely methodological; nonetheless, there are some hints of real changes.

Most of the species that were not found in the present survey are likely still present on the island. Due to

Table 2: Bryophyte species recorded earlier on the Islands of Brissago (Canton Ticino, Switzerland) and not found in the present study (2023-24).

Species	Years of record
<i>Brachythecium rivulare</i> Schimp.	1989
<i>Bryum pallens</i> Sw.	1986, 1987
<i>Chiloscyphus polyanthos</i> aggr.	1986
<i>Cynodontium polycarpon</i> (Hedw.) Schimp.	1986
<i>Didymodon fallax</i> (Hedw.) R.H. Zander	1986
<i>Fissidens crassipes</i> Bruch & Schimp.	1986
<i>Funaria hygrometrica</i> Hedw.	1987
<i>Grimmia longirostris</i> Hook.	1986
<i>Grimmia trichophylla</i> Grev.	1986
<i>Hygroamblystegium humile</i> (P. Beauv.) Vanderp. & al.	1989
<i>Lophocolea heterophylla</i> (Schrad.) Dumort.	1977
<i>Mnium stellare</i> Hedw.	1986
<i>Orthotrichum pallens</i> Brid.	2017
<i>Pellia epiphylla</i> (L.) Corda	1986
<i>Plagiomnium affine</i> (Funck) T.J. Kop.	1986
<i>Plagiochila porelloides</i> (Torr. ex Nees) Lindenb.	1986
<i>Pohlia nutans</i> (Hedw.) Lindb.	1986
<i>Pseudoscleropodium purum</i> (Hedw.) M. Fleisch.	1987
<i>Pseudotaxiphyllum elegans</i> (Brid.) Z. Iwats.	1986
<i>Rhizomnium punctatum</i> (Hedw.) T.J. Kop.	1986
<i>Riccia glauca</i> L.	1988
<i>Sciuro-Hypnum plumosum</i> (Hedw.) Ignatov & Huttunen, nom. cons.	1986
<i>Sciuro-Hypnum reflexum</i> (Stärke) Ignatov & Huttunen	1986

the shorter fieldwork for the 2023-24 inventory, it was not possible to search all areas of the islands down to the last detail. While our data resulted from 3 survey days, the previous data (Swissbryophytes 2004-2024) spans nearly 40 days, with Max Leimgruber registering mosses on the island for 29 days. Certainly, we may have overlooked some species, especially those that are present in identifiable form only seasonally or are present in small quantities under unfavourable growing conditions. For example, Leimgruber (1988) recorded the two ephemeral species *Funaria hygrometrica* and *Physcomitrium pyriforme*, whereas we could find only sterile plants that could not be definitively assigned to either of the two species. Likewise, newly found species likely include some that were already present on the islands but were previously overlooked. A considerable portion of the new species are those that were previously poorly known or insufficiently studied. For example, we found five species of the taxonomically challenging genus *Schistidium*, of which only one species was previously known from the islands, and nine additional Orthotrichaceae species (*Lewinskya* spp., *Orthotrichum* spp., *Ulota* spp.; Appendix 1). Leimgruber's (1988) work preceded taxonomic revisions and determination keys (e.g., Blom

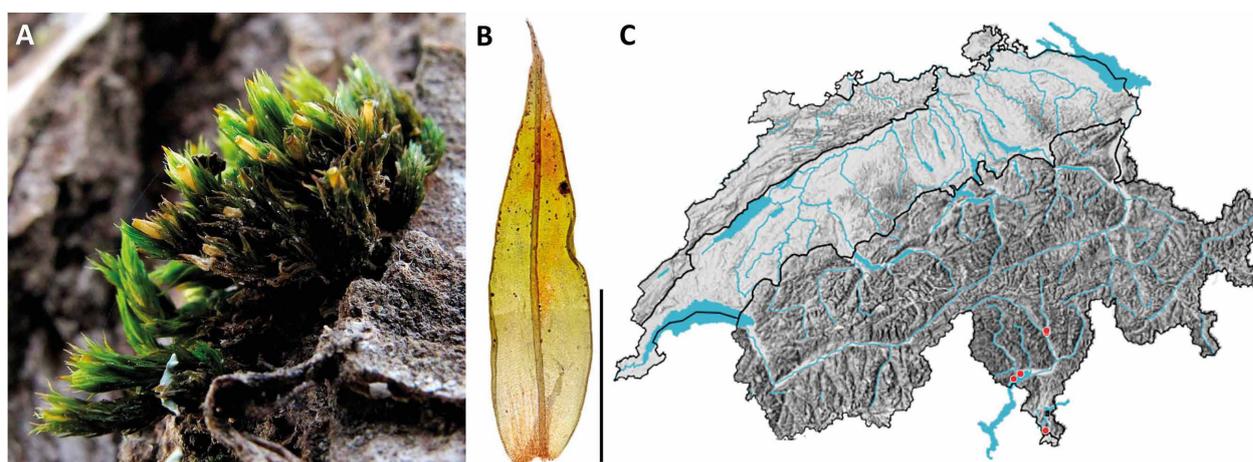


Figure 1: *Lewinskya acuminata* (H. Philib.) F. Lara & al. on the Brissago Islands (Canton Ticino, Switzerland). A: Tuft on the bark of a tree (photo: M. Lüth). B: Leaf with the typically long acuminate apex (Photo A. Büschlen). C: Distribution in Switzerland (© Swissbryophytes 2004-2024), red dots are records in or after 2000. Scale bar: B=1 mm.

1996; Lewinsky-Haapasaaari 1995; Ignatova et al. 2010; Caparros et al. 2016) that now facilitate the treatment of these groups.

However, a real addition is likely represented by the newly recorded *Lewinskya acuminata* (Fig. 1). This species was reported as new to Switzerland only 10 years ago (Kiebacher 2014; Vigalondo et al. 2014). It is very likely that this species, which is widespread in the Mediterranean region, is spreading northward due to climate warming. The present finding is the fourth known occurrence in Switzerland. The species is certainly more common than currently known, and is listed as near threatened (NT) in the Swiss Red List.

It is also noteworthy that there seems to be an increase in the abundance of *S. circinatum* and *S. deflexifolium*. Both species are absent from Leimgruber's inventory (1988), but *S. circinatum* was already known to be present at Lake Maggiore in the 50ties (Giacomini 1951), and F. Greter recorded *S. deflexifolium* on the Brissago Islands in 1970 (Swissbryophytes 2004-2024). Today, *S. circinatum* is found on almost all coastal cliffs, often in large quantities, and also forms large cushions on walls away from the water. It is difficult to imagine that Leimgruber would have overlooked this species, if it was already present in such abundance at that time. In contrast, *S. deflexifolium* still occurs only in locally limited areas, although it covers almost entirely a large rock at the edge of Sant'Apollinare's shore, which is hard to overlook. Both *Scorpiurium* species are thermophilic like *L. acuminata* (Dierssen 2001), suggesting that their spread is related to climate warming. The increase in thermophilic bryophyte species in Switzerland was observed also through the analysis of biodiversity monitoring data (Kiebacher et al. 2023). Furthermore, the new records of *Orthotrichum tenellum* and *Dicranoweisia cirrata* in this study coincide with observations in the rest of Switzerland and other areas of Europe suggesting an increase in abundance and spread of oceanic species (Caspari et al. 2018, Kiebacher et al. 2023).

Finally, it was surprising that despite targeted searches in damp locations, *Brachythecium rivulare* could not be re-found. All collected candidates were microscopically

assigned to *B. rutabulum*. *Brachythecium rivulare* occurs from lowlands to alpine regions but primarily shows a montane distribution (Grims 1999). Perhaps the occurrences in lowlands are decreasing due to climate warming.

Notes on the most threatened species and on *Trichostomum littorale*

Entodon cladorrhizans CR (PE)

This species was classified as possibly extinct in the current Red List of Switzerland, because the last record in Switzerland dates back over a hundred years and the species has not been rediscovered despite targeted searches at historical locations. *Entodon cladorrhizans* (Fig. 2) is widely distributed in eastern North America and East Asia, whereas only few records are known in Europe. Due to possible confusion with *E. schleicheri* that is widespread in Europe, *E. cladorrhizans* was assessed as data deficient in the European Red List (Campisi et al. 2019).

On San Pancrazio, *E. cladorrhizans* grew in a flower bed nearby the ditch, below the hotel. Some plants exhibited sporophytes, allowing us to unambiguously confirm the identity of the species using the sporophyte characteristics (Fig. 2D-E). Leaves of *E. cladorrhizans* are less concave and more gradually tapered than those of *E. schleicheri* (leaves strongly concave, not easily flattened by a cover glass, abruptly constricted in the upper fifth), and the end cell of the leaf lamina is on average shorter (approximately 1 time versus approximately 2 times as long as wide; check several leaves). Diagnostic characteristics of the sporophyte of *E. cladorrhizans* comprise the presence of an annulus (versus annulus absent) and peristome teeth ornamentation consisting of radially arranged papillae (versus oblique lines). The species' population in the flower bed consisted of a few mats only. During a second survey in April 2024, these were found in good condition with no signs of damage (Fig. 3). Conservation measures are currently being developed together with the garden administration.

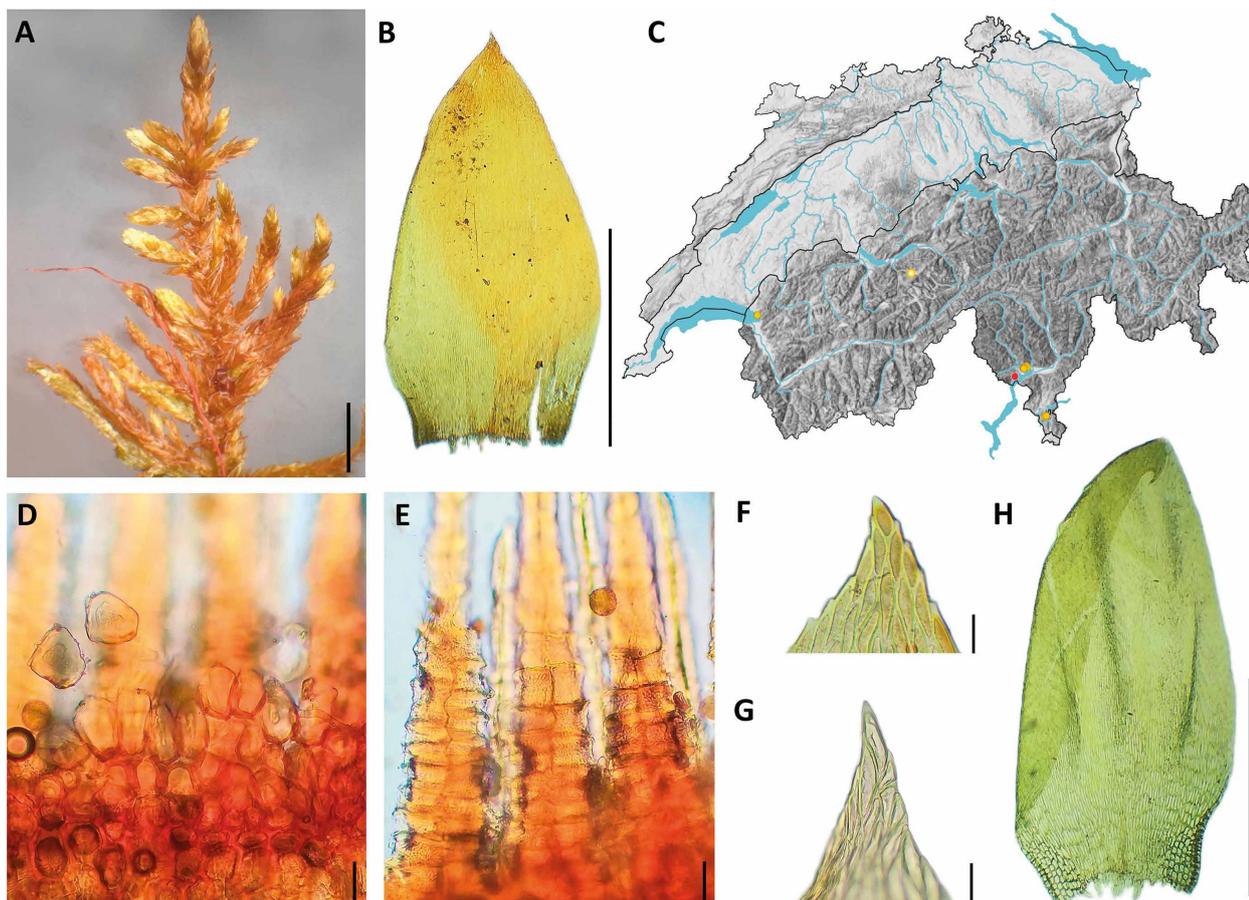


Figure 2: *Entodon* species of the Brissago Islands (Canton Ticino, Switzerland). A–F, *E. cladorrhizans* (Hedw.) Müll. Hal. and, G–H, *E. schleicheri* (Schimp.) Demet. A: Shoot. B, H: stem leaves. C: Distribution of *E. cladorrhizans* in Switzerland (© Swissbryophytes 2004–2024), yellow dots are records before 2000 and red dots are records in or after 2000. D: Annulus at capsule mouth. E: Ornamentation of peristome teeth. F, G: leaf apices. Scale bars: A=5 mm; B, H=1 mm; D–G=20 µm.

Scorpiurium deflexifolium CR

This species was first collected by F. Greter in 1970 and found again by E. Urmi in 1995 and 2017. During our 2023–24 survey, the species was confirmed at two locations on both San Pancrazio and Sant’Apollinare, with one location being previously unknown. The occurrence on the Brissago Islands is the only known occurrence of the species in Switzerland (Fig. 4). However, it is very likely that the species also occurs along the mainland shoreline of the Lake Maggiore in Switzerland, because it has been observed by G. Brusa (personal communication) on the Italian side near Ispra already in 1998. Therefore, it would be worthwhile to search the shore of Lake Maggiore, paying attention also to other species of conservation concern, such as *Bryum gemmiparum* and *Fissidens rivularis* observed in the present inventory. Except for a large rock boulder almost entirely covered by the species (Fig. 4), the population of *S. deflexifolium* on the Brissago Islands is small but currently in good condition, facing apparently no immediate threats.

Brachythecium capillaceum EN

This species was newly recorded during the 2023–24 surveys, making the Brissago Islands as the third currently known occurrence in Switzerland and the second in Canton Ticino (Kiebacher 2024; Fig. 5). We observed the species on the south-eastern part of San



Figure 3: Vital plant of *Entodon cladorrhizans* (Hedw.) Müll. Hal. in the flower bed at the ditch on San Pancrazio in April 2024.

Pancrazio close to the shore. *Brachythecium capillaceum* is mainly distributed in Asia, while in Europe it is widespread only in the easternmost regions. In Central and Western Europe, very few occurrences are known (Schnyder et al. 2019). Further occurrences in Ticino are very likely, and during searches attention should be paid to locations near water bodies.

Bryum gemmiparum EN

The discovery of *B. gemmiparum* on the Brissago Islands is the first in Ticino after more than hundred years. The species occurs at several sites on the coastal cliffs of the islands, and it is very likely that further occurrences exist along the mainland shores of Lake Maggiore. The presence of a single gemma per leaf axil is usually mentioned as a morphological feature to distinguish it from similar species. However, according to Holyoak (2021), plants with multiple gemmae per leaf axil can sometimes occur and were indeed observed on the Brissago Islands.

Fissidens rivularis EN

The last record of *F. rivularis* (Fig. 6) in Switzerland dates back over 25 years. In Switzerland, this thermo-

philic species has so far been recorded only in Ticino, including a nearby finding by M. Jäggi in 1941 from the municipality of Brissago (Swissbryophytes 2004-2024). The species was growing on San Pancrazio on the wall of a small water basin.

Trichostomum littorale NE

In the current Red List of Switzerland, *T. littorale* is included in the broad concept of *T. brachydontium*, because the taxonomic treatment of this species complex by Ros et al. (2022) was published after the editorial deadline of the Swiss Red List. Ros et al. (2022) segregated *T. brachydontium* s.l. into four morphologically and molecularly distinguishable species (*T. brachydontium* s.str., *T. herzogii*, *T. littorale* and *T. meridionale*) whose occurrences in Switzerland thus require further investigation. We collected several samples of *T. brachydontium* s.l. on the Brissago Islands, all of which belong to *T. littorale*. A further specimen was collected by the first author in the municipality of Orselina near Madonna del Sasso in 2022 (herb. T. Kiebacher 3287). Amann et al. (1918) and Amann (1933) provide records of *T. littorale* for Canton Ticino and one for Canton Vaud, but they actually suspected that the plants from Ticino



Figure 4: *Scorpiurium deflexifolium* (Solms) M. Fleisch. & Loeske on the Brissago Islands (Canton Ticino, Switzerland). A: Siliceous boulder covered with *S. deflexifolium* at the shore of Sant'Apollinare Island. B: Mat of *S. deflexifolium* showing the curved branches typical for the genus.

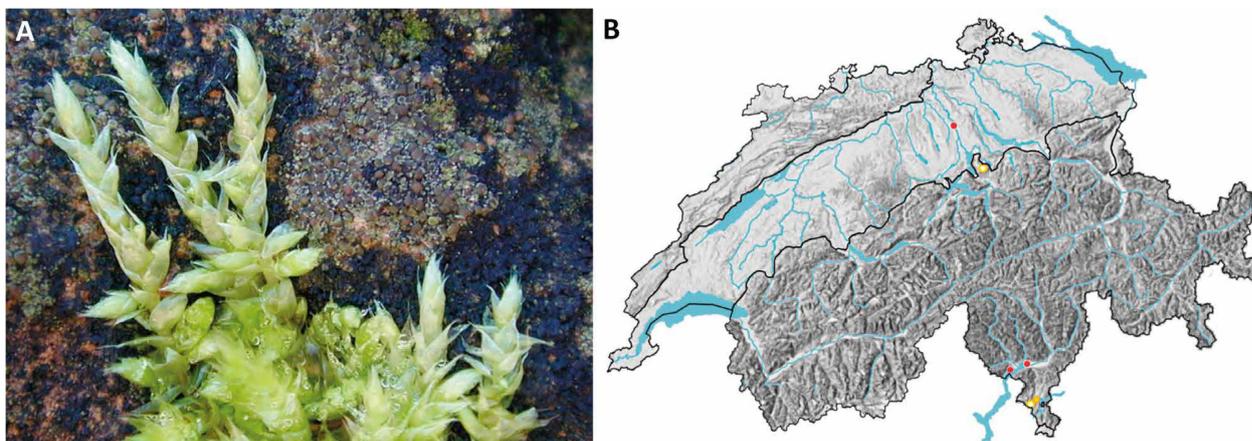


Figure 5: *Brachythecium capillaceum* (F. Weber & D. Mohr) Giacom. on the Brissago Islands (Canton Ticino, Switzerland). A: Shoot apices (photo: M. Lüth). B: Distribution in Switzerland (© Swissbryophytes 2004-2024), yellow dots are records before 2000 and red dots are records in or after 2000.

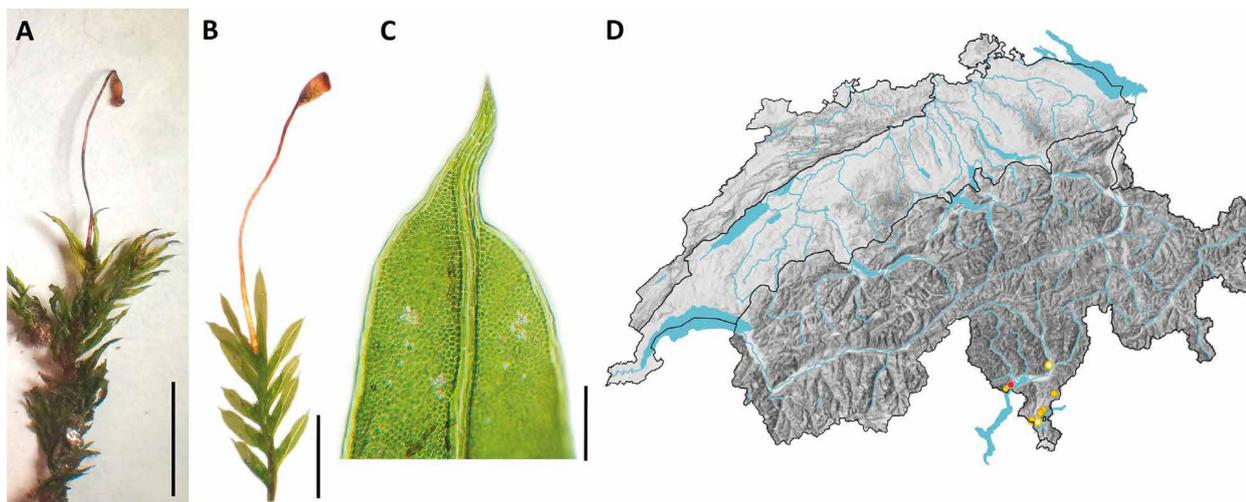


Figure 6: *Fissidens rivularis* (Spruce) Schimp. on the Brissago Islands (Canton Ticino, Switzerland). A: Dry shoot. B: Wet shoot. C: leaf apex. D: Distribution in Switzerland (© Swissbryophytes 2004-2024), yellow dots are records before 2000 and red dots are records in or after 2000. Scale bars: A=5 mm; B=2 mm; C=200 µm.

could rather belong to *T. brachydontium* s.str. (sub *T. mutabile* Bruch). However, Jäggi (1950) was convinced of the occurrence of *T. littorale* in Canton Ticino, and Leimgruber (1988) reports the species on the Brissago Islands.

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Appendix 1: List of bryophyte taxa recorded on the Brissago Islands (Canton Ticino, Switzerland) in 2023-24. Red List status for Switzerland (RL) according to Kiebacher, Meier et al. (2023). In bold: new taxa, not recorded in previous surveys on the Brissago Islands.

Liverworts	RL		LC
<i>Conocephalum conicum</i> aggr.	NE	<i>Bryum barnesii</i> J.B. Wood ex Schimp.	LC
<i>Frullania dilatata</i> (L.) Dumort.	LC	<i>Bryum capillare</i> Hedw.	LC
<i>Jungermannia</i> s.l.	NE	<i>Bryum gemmiferum</i> R. Wilczek & Demaret	VU
<i>Lejeunea cavifolia</i> (Ehrh.) Lindb.	LC	<i>Bryum gemmiparum</i> De Not.	EN
<i>Lophocolea</i> (Dumort.) Dumort.	NE	<i>Bryum moravicum</i> Podp.	LC
<i>Lunularia cruciata</i> (L.) Dumort. ex Lindb.	NA	<i>Bryum pseudotriquetrum</i> (Hedw.) G. Gaertn. & al.	LC
<i>Marchantia polymorpha</i> subsp. <i>ruderalis</i> Bischl. & Boissel.-Dub.	LC	<i>Bryum rubens</i> Mitt.	LC
<i>Metzgeria furcata</i> (L.) Corda	LC	<i>Calliergonella cuspidata</i> (Hedw.) Loeske	LC
<i>Porella platyphylla</i> aggr.	NE	<i>Calliergonella lindbergii</i> (Mitt.) Hedenäs	LC
<i>Radula complanata</i> (L.) Dumort. subsp. <i>complanata</i>	LC	<i>Campyliadelphus chrysophyllus</i> (Brid.) Kanda	LC
<i>Riccia bifurca</i> Hoffm.	VU	<i>Campylophyllopsis calcarea</i> (Crundw. & Nyholm)	LC
		Ochyra	
		<i>Campylopus pilifer</i> Brid.	LC
		<i>Campylopus pyriformis</i> (Schultz) Brid.	NT
Mosses		<i>Ceratodon purpureus</i> (Hedw.) Brid.	LC
<i>Amblystegium serpens</i> (Hedw.) Schimp.	LC	<i>Cirriphyllum crassinervium</i> (Taylor) Loeske & M.Fleisch.	LC
<i>Amphidium mougeotii</i> (Schimp.) Schimp.	LC	<i>Cirriphyllum piliferum</i> (Hedw.) Grout	LC
<i>Anomobryum julaceum</i> (Schrad. ex G. Gaertn. & al.) Schimp.	VU	<i>Climacium dendroides</i> (Hedw.) F. Weber & D. Mohr	LC
<i>Anomodon viticulosus</i> (Hedw.) Hook. & Taylor	LC	<i>Coscinodon cribrosus</i> (Hedw.) Spruce	LC
<i>Atrichum angustatum</i> (Brid.) Bruch & Schimp.	LC	<i>Cratoneuron filicinum</i> (Hedw.) Spruce	LC
<i>Atrichum undulatum</i> (Hedw.) P. Beauv.	LC	<i>Ctenidium molluscum</i> (Hedw.) Mitt.	LC
<i>Barbula unguiculata</i> Hedw.	LC	<i>Dialytrichia mucronata</i> (Brid.) Broth.	VU
<i>Brachythecium capillaceum</i> (F.Weber & D.Mohr) Giacom.	EN	<i>Dichodontium pellucidum</i> (Hedw.) Schimp.	LC
<i>Brachythecium laetum</i> (Brid.) Schimp.	LC	<i>Dicranella heteromalla</i> (Hedw.) Schimp.	LC
<i>Brachythecium rutabulum</i> (Hedw.) Schimp.	LC	<i>Dicranella staphylina</i> H. Whitehouse	LC
<i>Brachythecium salebrosum</i> (Hoffm. ex F. Weber & D. Mohr) Schimp., nom. cons.	LC	<i>Dicranoweisia cirrata</i> (Hedw.) Lindb.	LC
<i>Bryoerythrophyllum ferruginascens</i> (Stirt.) Giacom.	LC	<i>Dicranum montanum</i> Hedw.	LC
<i>Bryum alpinum</i> Huds. ex With.	LC	<i>Didymodon insulanus</i> (De Not.) M.O. Hill	NT
<i>Bryum argenteum</i> Hedw.	LC	<i>Didymodon luridus</i> Hornsch. ex Spreng.	LC
		<i>Didymodon rigidulus</i> Hedw.	LC
		<i>Didymodon spadiceus</i> (Mitt.) Limpr.	LC

<i>Ditrichum flexicaule</i> (Schwägr.) Hampe	LC	<i>Orthotrichum tenellum</i> Bruch ex Brid.	LC
<i>Encalypta streptocarpa</i> Hedw.	LC	<i>Oxyrrhynchium hians</i> (Hedw.) Loeske	LC
<i>Entodon cladorrhizans</i> (Hedw.) Müll. Hal.	CR (PE)	<i>Philonotis marchica</i> (Hedw.) Brid.	VU
<i>Eucladium verticillatum</i> (With.) Bruch & Schimp.	LC	<i>Plagiomnium cuspidatum</i> (Hedw.) T.J. Kop.	LC
<i>Fabronia ciliaris</i> aggr. [excl. pusilla, cf. altaica]	NE	<i>Plagiomnium rostratum</i> (Schrad.) T.J. Kop.	LC
<i>Fabronia pusilla</i> Raddi	LC	<i>Plagiomnium undulatum</i> (Hedw.) T.J. Kop.	LC
<i>Fissidens adianthoides</i> Hedw.	LC	<i>Plagiothecium nemorale</i> (Mitt.) A. Jaeger	LC
<i>Fissidens bryoides</i> aggr. [excl. gracilifolius]	NE	<i>Platygyrium repens</i> (Brid.) Schimp.	LC
<i>Fissidens cf. gracilifolius</i> Brugg.-Nann. & Nyholm	LC	<i>Polytrichum formosum</i> Hedw.	LC
<i>Fissidens dubius</i> P. Beauv.	LC	<i>Pseudanomodon attenuatus</i> (Hedw.) Ignatov & Fedosov	LC
<i>Fissidens osmundoides</i> Hedw.	LC	<i>Pseudoleskeella nervosa</i> (Brid.) Nyholm	LC
<i>Fissidens rivularis</i> (Spruce) Schimp.	EN	<i>Pterigynandrum filiforme</i> Hedw.	LC
<i>Fissidens taxifolius</i> Hedw.	LC	<i>Ptychomitrium polyphyllum</i> (Dicks. ex Sw.) Bruch & Schimp.	LC
<i>Fontinalis antipyretica</i> Hedw.	LC	<i>Pulvigerella lyellii</i> (Hook. & Taylor) Plášek & al.	LC
Funariaceae [<i>Physcomitrium</i> sp./ <i>Funaria hygrometrica</i>]	NE	<i>Pylaisia polyantha</i> (Hedw.) Schimp.	LC
<i>Grimmia elatior</i> Bruch ex Bals.-Criv. & De Not.	LC	<i>Rhabdoweisia fugax</i> (Hedw.) Bruch & Schimp.	LC
<i>Grimmia hartmanii</i> Schimp.	LC	<i>Rhynchostegiella tenella</i> (Dicks.) Limpr.	LC
<i>Grimmia laevigata</i> (Brid.) Brid.	LC	<i>Rhynchostegium confertum</i> (Dicks.) Schimp.	LC
<i>Grimmia lisa</i> De Not.	VU	<i>Schistidium apocarpum</i> (Hedw.) Bruch & Schimp.	LC
<i>Grimmia ovalis</i> (Hedw.) Lindb.	LC	<i>Schistidium crassipilum</i> H.H. Blom	LC
<i>Grimmia pulvinata</i> (Hedw.) Sm.	LC	<i>Schistidium elegantulum</i> H.H. Blom	LC
<i>Gymnostomum aeruginosum</i> Sm.	LC	<i>Schistidium lancifolium</i> (Kindb.) H.H. Blom	VU
<i>Habrodon perpusillus</i> (De Not.) Lindb.	LC	<i>Schistidium papillosum</i> Culm.	LC
<i>Hedwigia ciliata</i> (Hedw.) P. Beauv.	LC	<i>Sciuro-Hypnum flotowianum</i> (Sendtn.) Ignatov & Huttunen	NT
<i>Homalothecium sericeum</i> (Hedw.) Schimp.	LC	<i>Sciuro-Hypnum populeum</i> (Hedw.) Ignatov & Huttunen	LC
<i>Homomallium incurvatum</i> (Schrad. ex Brid.) Loeske	LC	<i>Scorpiurium circinatum</i> (Bruch) M. Fleisch. & Loeske	NT
<i>Hygroamblystegium varium</i> (Hedw.) Mönk.	LC	<i>Scorpiurium deflexifolium</i> (Solms) M. Fleisch. & Loeske	CR
<i>Hypnum andoi</i> A.J.E.Sm.	LC	<i>Streblotrichum convolutum</i> (Hedw.) P.Beauv.	LC
<i>Hypnum cupressiforme</i> Hedw.	LC	<i>Syntrichia fragilis</i> (Taylor) Ochyra	NT
<i>Isothecium alopecuroides</i> (Lam. ex Dubois) Isov.	LC	<i>Syntrichia pagorum</i> (Milde) J.J. Amann	LC
<i>Leptodon smithii</i> (Hedw.) F. Weber & D. Mohr	LC	<i>Syntrichia papillosa</i> (Wilson) Jur.	LC
<i>Leptophascum leptophyllum</i> (Müll. Hal.) J. Guerra & M.J. Cano	NA	<i>Thamnobryum alopecurum</i> (Hedw.) Gangulee	LC
<i>Leskea polycarpa</i> Hedw.	LC	<i>Thuidium delicatulum</i> (Hedw.) Schimp.	LC
<i>Leucodon sciuroides</i> (Hedw.) Schwägr.	LC	<i>Timmiella anomala</i> (Bruch & Schimp.) Limpr.	NT
<i>Lewinskya acuminata</i> (H.Philib.) F. Lara & al.	NT	<i>Tortella fasciculata</i> (Culm.) Culm.	LC
<i>Lewinskya affinis</i> (Schrad. ex Brid.) F. Lara & al.	LC	<i>Tortella tortuosa</i> (Hedw.) Limpr.	LC
<i>Lewinskya rupestris</i> (Schleich. ex Schwägr.) F. Lara & al.	LC	<i>Tortula muralis</i> Hedw.	LC
<i>Lewinskya striata</i> (Hedw.) F. Lara & al.	LC	<i>Trichodon cylindricus</i> (Hedw.) Schimp.	LC
<i>Microeurhynchium pumilum</i> (Wilson) Ignatov & Vanderp.	VU	<i>Trichostomum littorale</i> Mitt.	NE
<i>Neckera besserii</i> (Lobarz.) Jur.	LC	<i>Trichostomum crispulum</i> Bruch	LC
<i>Neckera complanata</i> (Hedw.) Huebener	LC	<i>Ulota crispula</i> Bruch	LC
<i>Orthotrichum anomalum</i> Hedw.	LC	<i>Ulota hutchinsiae</i> (Sm.) Hammar	LC
<i>Orthotrichum diaphanum</i> Schrad. ex Brid.	LC	<i>Weissia controversa</i> Hedw.	LC
<i>Orthotrichum microcarpum</i> De Not.	NT	<i>Zygodon rupestris</i> Schimp. ex Lorentz	LC
<i>Orthotrichum patens</i> Bruch ex Brid.	LC		
<i>Orthotrichum schimperi</i> Hammar	LC		
<i>Orthotrichum stellatum</i> Brid.	VU		