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The distribution of bryophytes in Switzerland and Liechtenstein. IV. *Hamatocaulis* and *Pseudocalliergon*

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Abstract

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The geographical distributions, in the form of mosaic maps, altitudinal ranges, frequencies, habitat requirements, and threat status of the four pleurocarpous wetland mosses *Hamatocaulis vernicosus*, *Pseudocalliergon lycopodioides*, *P. trifarium*, and *P. turgescens* in Switzerland are presented. The total and European ranges of the taxa are outlined. *Hamatocaulis vernicosus* is widely distributed over the whole of Switzerland, with a concentration of finds in the NE, though not common. *Pseudocalliergon lycopodioides* also occurs scattered all over the country, but fewer records from a narrower vertical range than for the former are known. Both species appear to have decreased at lower altitudes during the last decades. *Pseudocalliergon trifarium* is the most frequent of the studied taxa, more common in the east, and with the widest altitudinal span, but it has also considerably declined north of the Alps. While widespread in Europe, *P. turgescens* was known from a restricted area in Switzerland, where it has not been collected after 1953. The disappearance and deterioration of suitable wetlands is the likely proximate cause for the observed declines.

Key words: Wetlands, Amblystegiaceae, land use, frequency change.

Introduction

This paper is the fourth in a series on the geographical distributions of Swiss bryophytes (Bisang 1999; Bisang et al. 1998; Geissler et al. 2002). In addition, a paper

The authors were supported by the Swiss Bryophyte Mapping Group (NISM).

presenting the distribution of the Swiss *Sphagnum* species was published by Feldmeyer-Christe et al. (2001). The project to map the distributions of bryophytes in Switzerland, "Naturräumliches Inventar der Schweizer Moosflora" (NISM), started in 1984. A general introduction to this series was provided by Bisang et al. (1998). This contribution presents four members of the family Amblystegiaceae s. l., *Hamatocaulis vernicosus* (Mitt.) Hedenäs, *Pseudocalliergon lycopodioides* (Brid.) Hedenäs, *P. trifarium* (Web. & Mohr) Loeske, and *P. turgescens* (T. Jens.) Loeske, which occur mainly in relatively mineral-rich wetland environments.

Despite recent systematic investigations (Hedenäs 1998a; Vanderpoorten et al. 2002a, b), the relationships within the Amblystegiaceae s. l. remain partly unresolved and further studies of additional genes and species are necessary to achieve a definitive reclassification of all taxa in this family. Nevertheless, recent data show that *Hamatocaulis* and *Pseudocalliergon* belong to different clades within the Amblystegiaceae s. l., and that *Hamatocaulis* should be placed within the Calliergonaceae rather than in the Amblystegiaceae s. str. (Vanderpoorten et al. 2002a, b).

Members of the Amblystegiaceae s. l. occur in a wide variety of wetland types, from relatively acid to strongly calcareous and from nutrient-poor to nutrient-rich habitats. A few species, such as *Warnstorfia fluitans* (Hedw.) Loeske and *Straminergon stramineum* (Brid.) Hedenäs, can grow in bogs, whereas most other species are restricted to minerotrophic habitats. The latter include fens, wet meadows, springs, flushes, ponds, late snow-beds, and temporarily dry depressions in rocks and soil.

Many species of the Amblystegiaceae have decreased considerably in most parts of Europe due to the deterioration of wetlands (Berg and Wiehle 1992; Düll 1987; Grüttnner 1990; Kooijman 1992). In most countries of the European Union only one or a few percent of the original mire area remains today (Raeymaekers 2000). Also in Switzerland the wetland area has decreased considerably, especially in the hill regions north of the Alps (Mittelland) (cf. Fig. 5 and Hangartner 1997). Even if the Mittelland has been most heavily affected, many wetland types at higher altitudes are also influenced by changed agricultural practices, such as the closing down of many farms, or peat cutting, drainage, and intensified fertilisation on those farms that still remain (Grünig 1994).

In the following, the Swiss distributions of *H. vernicosus*, *P. lycopodioides*, *P. trifarium*, and *P. turgescens* are mapped. The distributions in Switzerland are compared with the European and total ranges of the species, with climatic factors, habitat requirements, and historical factors. The information provides a basis for further study of the species as well as for monitoring changes in the frequencies and distributions of the treated species.

Material and Methods

In view of recent results from revisions of species and genera, as well as of internal relationships within the Amblystegiaceae s. l. (Hedenäs 1989, 1992; Vanderpoorten et al. 2002a, b), names that reflect phylogenetic relationships are used in this paper rather than the more conservative nomenclature of Geissler et al. (1998). In the latter, *H. vernicosus* is called *Drepanocladus vernicosus* (Mitt.) Warnst., *P. lycopodioides* is named *Drepanocladus lycopodioides* (Brid.) Warnst., *P. trifarium* is called *Calliergon trifarium* (Web. & Mohr) Kindb., and *P. turgescens* is found under *Scorpidium turgescens* (T. Jens.) Loeske.

The present distribution maps are mosaic maps that are based on a system of physiographic units. For Switzerland these include 413 and for Liechtenstein two units that are as homogeneous as possible regarding geology and climate (Urmi and Schnyder 1996). Every symbol represents the occurrence of a certain species within a physiographic unit, regardless of its frequency. Finds are differentiated as to time (before and since 1960) and for those since 1960 also as to altitude (see legend of Fig. 1). The geographical subdivision of Switzerland follows Gutersohn (1973).

The distribution maps are largely based on relevés and collections that were made within the framework of NISM. All data are stored in a database at the Computing Centre of the University of Zürich. The specimen data result partly from a systematic field survey (Urmi et al. 1990), and partly from a revision of herbarium material from the following herbaria: BAS, BERN, CHUR, G, H, LAU, LUG, NEU, NMLU, NY, S, Z, ZT, Frauenfeld, St. Gallen, Winterthur, and Zug. Vouchers for newer finds are found in G, Z, or in the private herbaria of the collaborators. Data from other projects were also included in the database (Bergamini et al. 2001; Grünig 1997; Grünig et al. 1986; Hangartner 1997; Schnyder 1993; Zimmerli 1988). The European and total geographical ranges of the four included species follow Hedenäs (1989, 1992, 2002, in press). Threat status in Switzerland and Europe were retrieved from Urmi et al. (1992) and ECCB (1995), respectively. Ongoing work on a revised version of the Swiss bryophyte Red List was also considered.

The pH indications are based on own measurements (Hedenäs, unpublished data, Hedenäs and Kooijman, unpublished data) and literature (Albertson 1946; Apinis and Lacis 1936; Krusenstjerna 1945; Sørensen 1948; Witting 1949). Although most of the pH measurements were made in N Europe, personal field experience and a few pH measurements from Switzerland suggest that the pH preferences of the study species are approximately similar in these geographical areas.

***Hamatocaulis vernicosus* (Mitt.) Hedenäs**

A pleurocarpous moss of the order Hypnales. Worldwide, *Hamatocaulis* consists of two species, both occurring in Europe, but only one in Switzerland. Usually more or less upright, more or less pinnately branched shoots with uppermost stem portion bent like a walking stick; green with a slightly greyish or bluish tone, often with red colour in a zone just above leaf insertion, rarely larger portions red. Leaves from erect base suddenly curved in one direction in their distal part, distinctly plicate; costa single and long. Dioicous; sporophytes relatively rare, mature in summer.

Habitat requirements: In fens and wet meadows, predominantly in connection with spring influence or moving water; rarely in tree-covered wetlands. Mostly in slightly nutrient-enriched and mineral-rich, but often not especially calcareous habitats; pH 5.4–7.3 at eight Swiss occurrences (in northern Europe pH 5.7–7.8).

Geographical distribution: In North and South America, Asia, and doubtfully occurring in Africa (Algeria); in Europe widespread, but rarely common, rare or absent in the Mediterranean area. In Switzerland in total 164 records, of which 71 from 1960 or later. Scattered localities all over Switzerland, but with concentrations in E part of the Mittelland and adjoining areas of the northern Alps, as well as in the Bernese part of the northern Alps. Altitudinal span from 390 to 2400 m a.s.l. with median 50% of known finds between 600 and 1300 m.

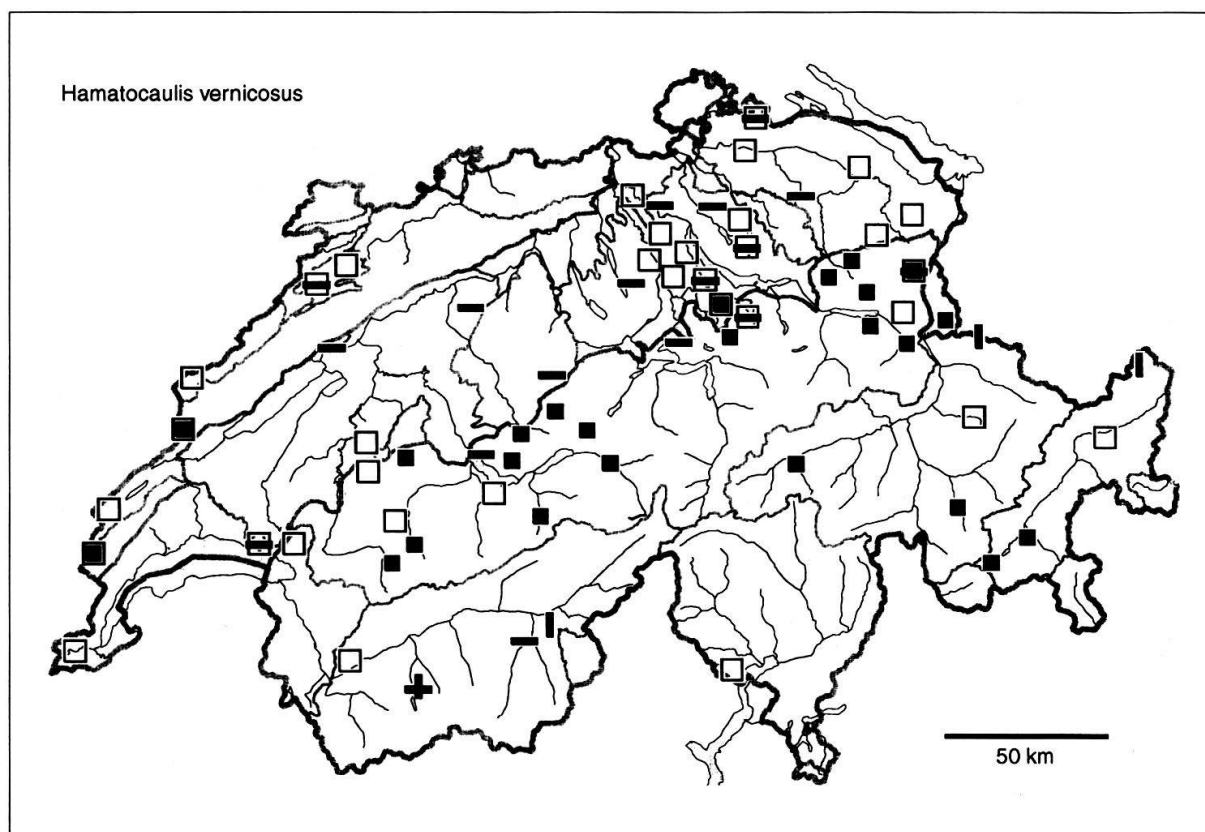


Fig. 1. *Hamatocaulis vernicosus* (Mitt.) Hedenäs [Order Hypnales]. In Figs. 1–4, finds are differentiated as to time (open symbols: before 1960; filled symbols: since 1960), and those since 1960 as to altitude (■ ≤ 1000 m; ■ 1001–2000 m; ■ > 2000 m).

Threat: Classified as vulnerable (V) in Switzerland, and included on the appendix of threatened species of the BERN convention and on the EU Habitat Directive approved in May 1992 (ECCB 1995). A decrease at lower altitudes in Switzerland obvious from the distribution map.

Literature: Hedenäs (1989).

***Pseudocalliergon lycopodioides* (Brid.) Hedenäs**

A pleurocarpous moss of the order Hypnales. Worldwide, the genus *Pseudocalliergon* includes five species, all occurring in Europe, and three in Switzerland. Creeping to ascending, mostly relatively sparsely pinnately branched shoots; green or mostly with secondary yellow to brownish yellow colour, when dry with spots having a golden metallic gloss. Leaves falcate-secund, concave; costa single, long but relatively weak. Dioicous; sporophytes rare, also in Switzerland, mature in summer.

Habitat requirements: In shallow and usually treeless wetlands, survives drying out for shorter or longer periods during summer. In natural depressions in rock or soil, but also in anthropogenic habitats, such as ditches; relatively rare in fens, but now and then in wet meadows. In strongly calcareous habitats with a pH between 6.0 and 8.2.

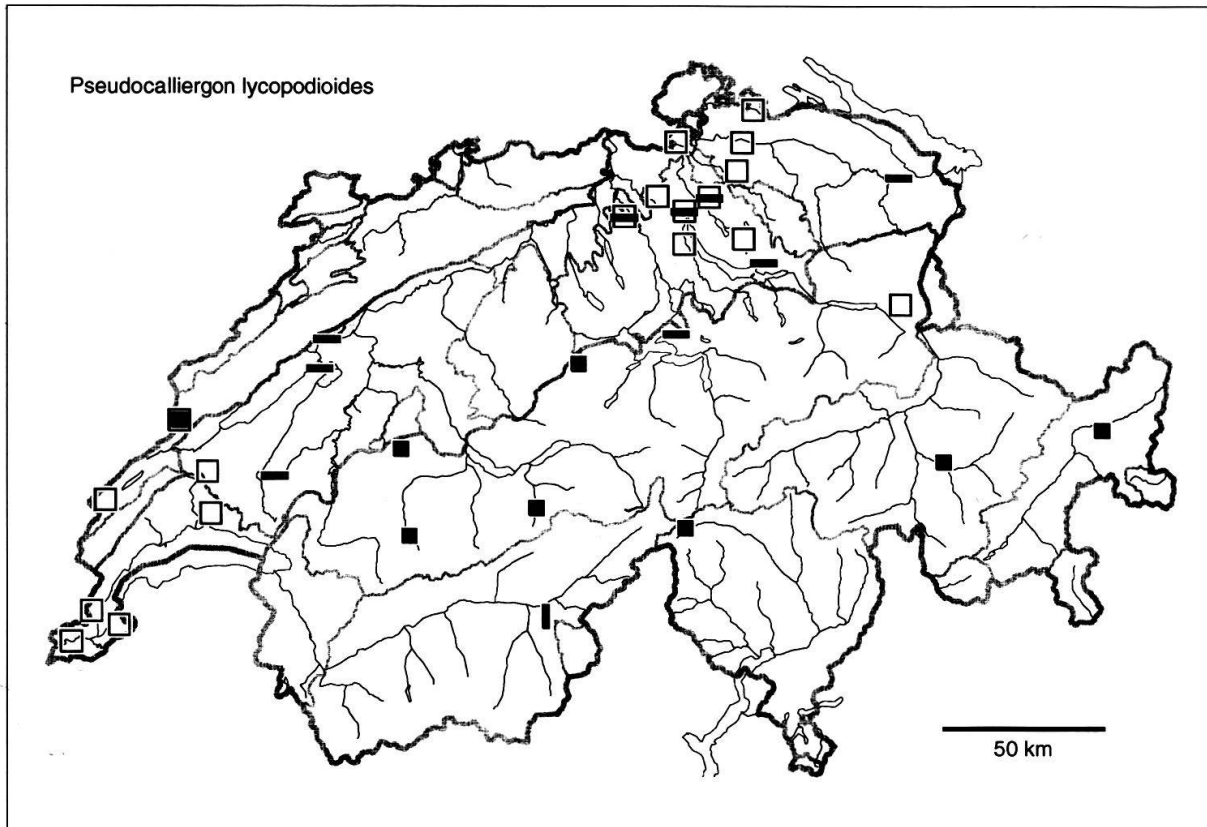


Fig. 2. *Pseudocalliergon lycopodioides* (Brid.) Hedenäs [Order Hypnales]. Time periods and altitudes are explained in the legend of Fig. 1.

Geographical distribution: Endemic to Europe and westernmost Asia, just east of the Ural Mountains; in Europe widespread and in some areas relatively common. In total 89 finds from Switzerland, 26 of which made after 1959. Most old Swiss finds in the NE and SW portions of the Mittelland, recent finds scattered in the Mittelland and the Alps. Occurs between 390 and 2050 m a.s.l. with median 50% of finds between 400 and 1000 m.

Threat: Until recently not considered threatened in Switzerland; however, since only few and scattered recent finds in the Mittelland, to be included in the revised Red List, the provisional status is VU D2 (vulnerable).

Literature: Hedenäs (1992).

***Pseudocalliergon turgescens* (T. Jens.) Loeske**

For general information about the genus, see *P. lycopodioides*. Creeping to more or less upright, not or sparsely branched, turgid shoots; green or mostly with secondary yellow to brownish yellow colour, when dry mostly with spots having a golden metallic gloss. Leaves straight and erect, strongly concave, and mostly imbricate, above suddenly narrowed to broad and shortly apiculate apex; costa double, short. Dioicous, most

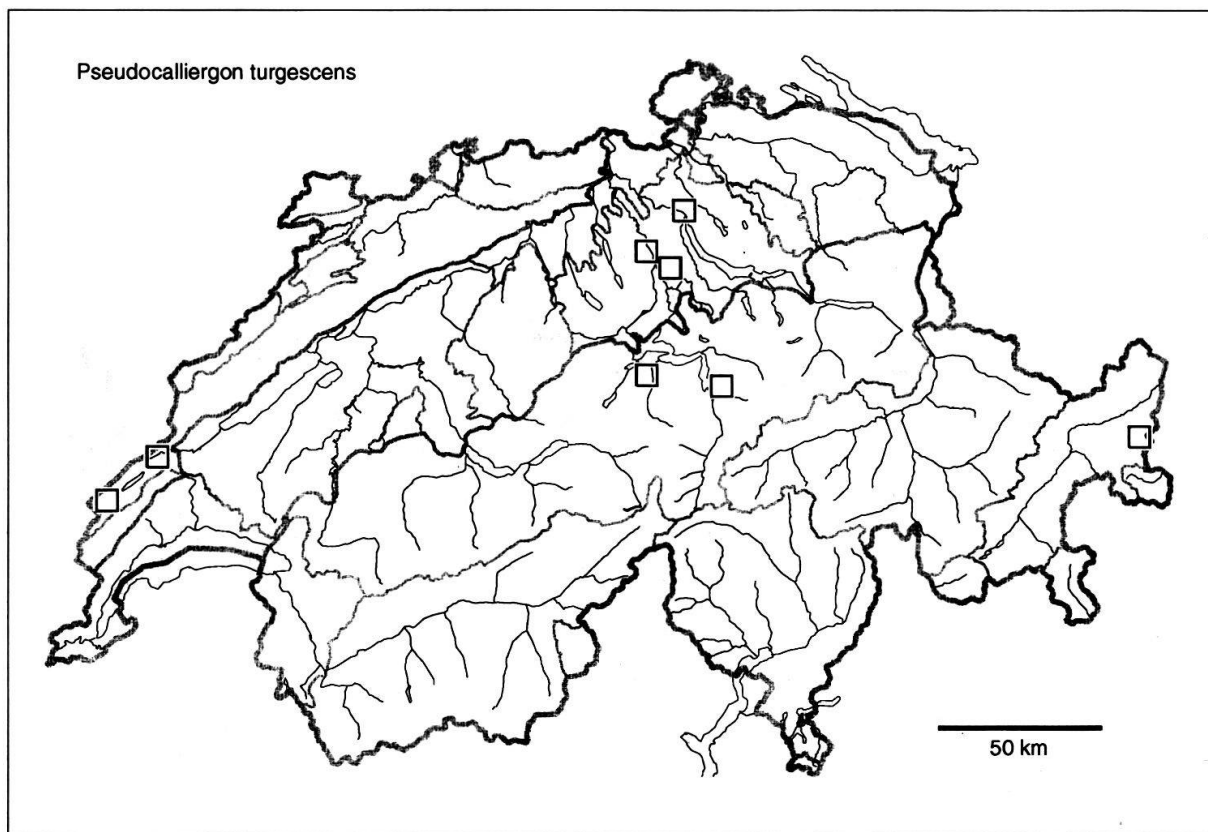


Fig. 3. *Pseudocalliergon turgescens* (T. Jensen) Loeske [Order Hypnales]. Time periods and altitudes are explained in the legend of Fig. 1.

populations sterile (at least in N Europe), male expressing plants rarer than female expressing ones; sporophytes rare, especially in central Europe, unknown from Switzerland.

Habitat requirements: In shallow, treeless wetlands, often drying out for shorter or longer periods during the summer, for example shallow depressions in rock or soil, or sometimes on rocks with at least periodically trickling water; also on grazed calcareous ground where animals and management reduce competition from vascular plants, in gravel pits, and, more rarely, in shallow fens or on lake shores. In strongly calcareous habitats or, when water is moving through the moss, in less mineral-rich environments; pH from (5.9) 6.7 to 8.6.

Geographical distribution: In North and South America and in Asia; in Europe widespread and locally moderately frequent in the north, relatively rare in the regions surrounding the Alps. In Switzerland 15 records, of which none recent. Known from a few old populations in the NE portion of the Mittelland, in the SW portion of the Jura mountains, and in the Alps. Altitudinal span from 390 to 2350 m a.s.l. with median 50% of known finds between 400 and 1000 m.

Threat: Considered vulnerable (V) in the Swiss Red List, not endangered in Europe because of many and strong populations in the northern portion of the continent. Searched for, but not re-found at two formerly known localities in 2002, and no other extant localities known. Therefore potentially extinct or has drastically declined in

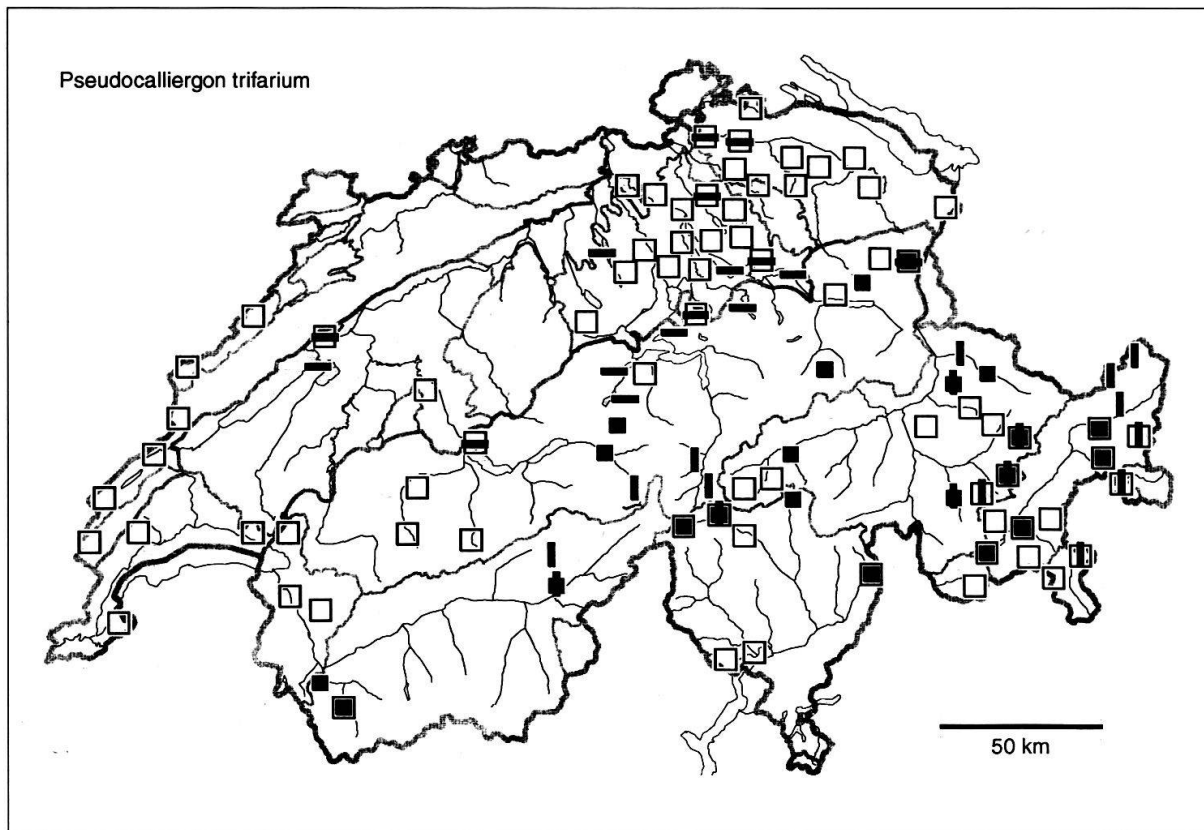


Fig. 4. *Pseudocalliergon trifarium* (Web. & Mohr) Loeske [Order Hypnales]. Time periods and altitudes are explained in the legend of Fig. 1.

Switzerland, likely due to changes in land-use. Included in the Red Lists of Austria (Grims 1986), Germany (Ludwig et al. 1996), and Italy (Cortini Pedrotti and Aleffi 1992).

Literature: Bisang and Hedenäs (2000), Hedenäs (1992, 2002), Paul (1924).

***Pseudocalliergon trifarium* (Web. & Mohr) Loeske**

For general information about the genus, see *P. lycopodioides*. Creeping or ascending, unbranched or sparsely branched shoots; usually yellow or brownish yellow. Leaves straight, usually erect and imbricate along most of shoots, concave, with broadly rounded apex; costa single and ending in upper part of leaf. Dioicous; sporophytes very rare (in Switzerland found once, in 1931).

Habitat requirements: In deep fens or in sloping fens with moving water, rarely on lake shores or on rocks with trickling water; most frequent in mineral-rich areas; pH at twelve Swiss occurrences between 6.2 and 8.1 (in northern Europe pH 5.6–7.6). Often found together with *Scorpidium scorpioides* (Hedw.) Limpr.

Geographical distribution: In North and South America, and in Asia; widespread in Europe, where it is relatively common in the boreal zone. In Switzerland in total 284 finds, 79 records from 1960 or later. Distributed all over the country, especially abun-

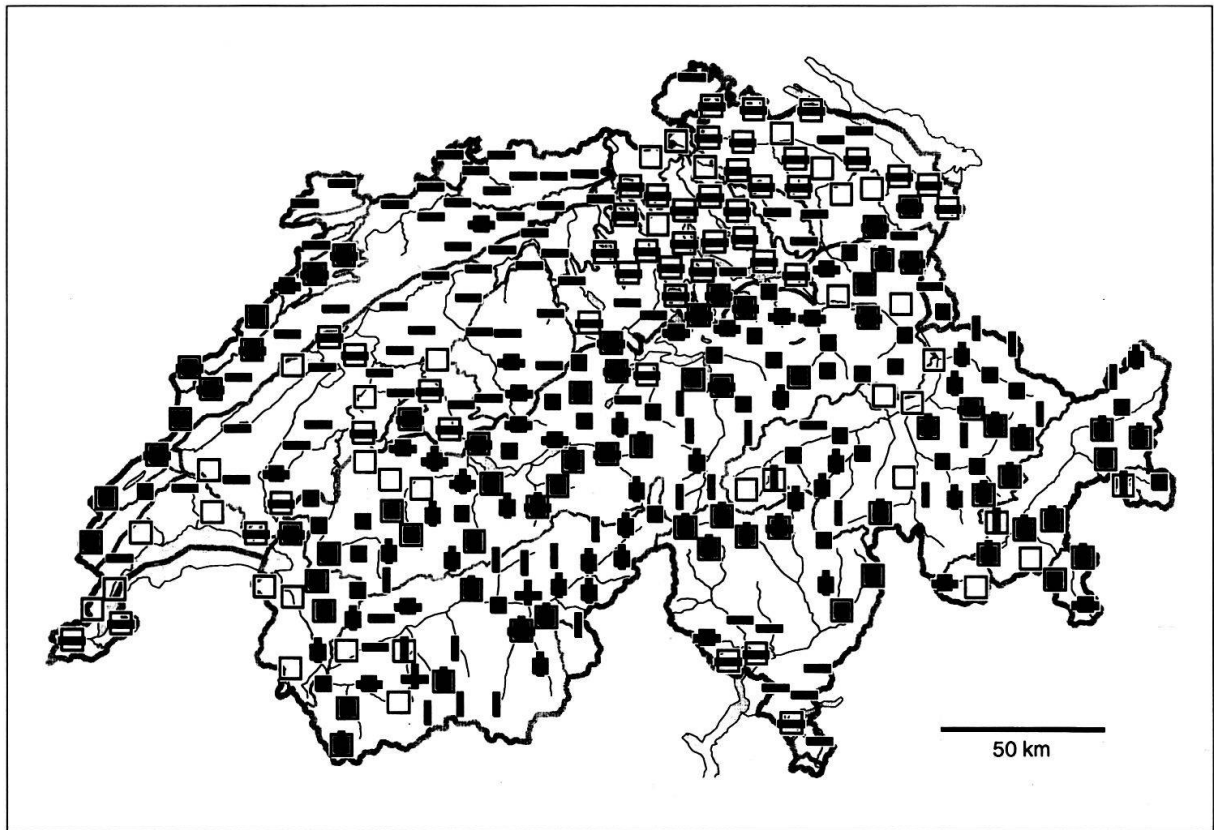


Fig. 5. Joint distribution map for all Swiss finds of *Calliergon* spp., *Campylium stellatum* (Hedw.) C. E. O. Jensen, *Drepanocladus* spp., *Hamatocaulis vernicosus* (Mitt.) Hedenäs, *Pseudocalliergon* spp., *Scorpidium* spp., *Straminergon stramineum* (Brid.) Hedenäs, *Tomentypnum nitens* (Hedw.) Loeske, and *Warnstorfia* spp. Note that *Sanionia uncinata* (Hedw.) Loeske, which rarely grows in real wetlands in Switzerland, is not included.

dant in the NE portion of the Mittelland and the eastern Alps. Very few recent finds from the Mittelland, the Jura mountains, and the northern slope of the western Alps. Altitudinal span from 240 to 2480 m a.s.l. with median 50% of finds between 500 and 1800 m.

Threat: Not included in the Swiss Red List. Relatively few recent finds compared with the known old ones may indicate a decline in some areas, still frequent in at least some areas of Graubünden.

Literature: Hedenäs (1992).

Discussion

The distribution of the collected specimens of *Hamatocaulis* and *Pseudocalliergon* is uneven over both space and time (Figs. 1–4). The first can be explained by irregular occurrences of suitable habitats or uneven collecting activities, whereas the latter may either be due to the latter factor or may reflect a real decline of the species in nature. In order to evaluate patterns of geographical distributions of individual wetland moss-

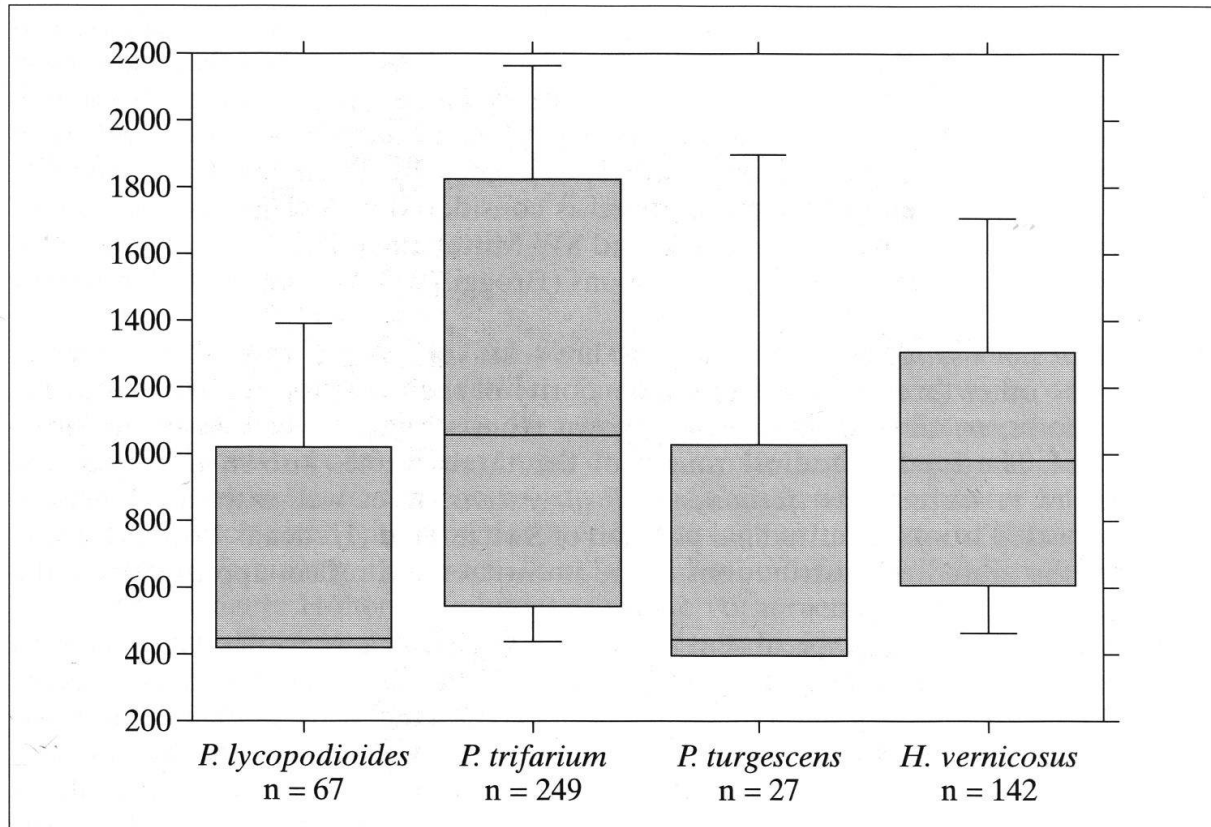


Fig. 6. Altitudinal distribution of the Swiss *Hamatocaulis* and *Pseudocalliergon* species. 50% of the records of a species are found within the altitudinal range represented by the boxes, 80% within the span between the bar endpoints, and 10% each originate from below and above, respectively. The line within the boxes indicates the median. The numbers of observations for each taxon are given below the names.

es, we provide a background map where the distribution of all Swiss collections of *Calliergon* spp., *Campylium stellatum* (Hedw.) C. E. O. Jensen, *Drepanocladus* spp., *Hamatocaulis vernicosus*, *Pseudocalliergon* spp., *Scorpidium* spp., *Straminergon stramineum*, *Tomentypnum nitens* (Hedw.) Loeske, and *Warnstorfia* spp. is indicated (Fig. 5). These taxa occur in most Swiss wetland types without closed tree cover, excluding running waters such as larger brooks and rivers. Accordingly, their joint distribution pattern reflects the occurrence of such wetland habitats in the wide sense. A gap in the geographic distribution of a species that corresponds to a gap of the entire species group can thus be explained by factors common to all such species. On the other hand, a distribution gap of an individual species that does not correspond to a gap of the entire species set is probably due to factors affecting this particular species. A certain species may, for example, have specific chemical or climatic requirements. The same reasoning applies to frequency changes over time.

In the total wetland material there are relatively few collections from the higher and southern Alps and from the middle portion of the Mittelland and adjoining parts of the Jura mountains (Fig. 5). These areas poor in specimens correspond to those with relatively few bogs and fens of national or regional importance (Grünig 1994). Because

common species such as *Bryum argenteum* Hedw. were collected in areas where wetlands are scarce (cf., Bisang et al. 1998), the lack of collections of wetland species in such regions reflect the scarcity of wetlands rather than a general undercollecting in these areas. Thus, the absence or scarcity of *Hamatocaulis* and *Pseudocalliergon* species in these geographical areas are best explained by a general lack of suitable wetland habitats. When the temporal aspect is considered, it is clear that the lack of recent finds in some portions of the NE and SW Mittelland is due to deterioration or destruction of many wetlands in these regions (Broggi 1990; Grünig 1994; Hangartner 1997).

Localities of *Pseudocalliergon trifarium* are relatively frequent up to 1800 m a.s.l., whereas the other three species have the majority of their localities at lower altitudes (Fig. 6). However, all four species are known from scattered localities up to 2050–2400 m a.s.l. The total altitudinal ranges of the three species known also from the Americas, *H. vernicosus*, *P. trifarium*, and *P. turgescens*, agree well with the respective ranges expected from the latitudinal position of Switzerland (Hedenäs 1999). This suggests that the altitudinal distributions found in Switzerland reflect approximately the climatic ranges of the species.

Hamatocaulis vernicosus is absent from many regions where wetland mosses were collected in Switzerland. This may be explained by the fact that this species occurs within a relatively narrow habitat (Hedenäs 1999). It is therefore unlikely that it was ever really common. In connection with the general degradation of wetlands and hydrological changes in the landscape it has disappeared from many former localities in the most heavily affected parts of Switzerland. Similar frequency decreases occurred in large parts of Europe (Hedenäs 1998b; Nebel 2001; Touw and Rubers 1989). However, the taxon's status on the continent as a whole is still somewhat unclear.

Pseudocalliergon lycopodioides has not been found recently in the area around the Lake of Geneva (Région lémanique) and few records are known from the northeastern Mittelland. Because many of its earlier localities were situated in these areas, the mentioned changes in the landscape have strongly affected the species' frequency in Switzerland. The new finds from other parts of Switzerland most likely reflect an increased collecting activity. Also *P. turgescens* has been severely affected by the decline in number of suitable localities in Switzerland. This species was never frequent in Switzerland, and no recent finds are known. However, the taxon may well have survived at its high altitude locality in the eastern Alps, since there are no indications of severe habitat changes in this region. *Pseudocalliergon trifarium* was originally much more common than either of the previous two species. It is currently known from many more localities than *P. lycopodioides* or *P. turgescens*. Nevertheless, the overall frequency decrease in *P. trifarium* is drastic.

Wetlands were severely influenced by changed and intensified landscape use in Central Europe. It is therefore not surprising that the frequencies of these four wetland species have decreased considerably in at least parts of their Swiss ranges. Since the Mittelland was most heavily affected by modern management it was expected that the strongest declines of the four treated taxa should be found in this region. If we want to sustain Mittelland populations of the three species that still occur there, these need to be investigated and monitored to find appropriate measures to support their long-term survival. However, even if it is considered enough to maintain viable populations somewhere in Switzerland the present overview suggests that all four species should be evaluated further. Even *P. trifarium*, the studied species that was once most widely distrib-

uted, has drastically decreased, which suggests that the cause may be a major change in wetland quality also in other regions than the Mittelland.

We thank the collaborators of the NISM, especially Bruno Bagutti and Heike Hofmann, who have contributed with data used in the present study. Comments from Edi Urmi considerably improved the paper.

Zusammenfassung

Die geografische Verbreitung der pleurokarpen Sumpf-Moose *Hamatocaulis vernicosus*, *Pseudocalliergon lycopodioides*, *P. trifarium* und *P. turgescens* in der Schweiz wird in Mosaik-Karten dargestellt. Ihre Höhenverteilung, Habitatsansprüche und der Gefährdungsgrad werden erörtert und die weltweite und europäische Verbreitung dargestellt. *Hamatocaulis vernicosus* ist in der Schweiz weit verbreitet und tritt vor allem, wenn auch nicht häufig, in der Nordostschweiz auf. *Pseudocalliergon lycopodioides* kommt vereinzelt im ganzen Land vor, aber an weniger Fundorten und weist auch eine geringere Höhenverteilung auf als die vorhergenannte Art. Beide scheinen in den letzten Jahrzehnten in tiefen Lagen seltener geworden zu sein. *Pseudocalliergon trifarium* ist die häufigste Art. Ihr Verbreitungsschwerpunkt liegt in der Ostschweiz. Sie weist die ausgedehnteste Höhenverteilung auf, ist aber auf der Alpennordseite ebenfalls seltener geworden. Obwohl in Europa weit verbreitet, war *P. turgescens* nur von einem beschränkten Gebiet in der Schweiz bekannt und wurde seit 1953 nicht mehr in der Schweiz gesammelt. Das Verschwinden und die Zerstörung der Feuchtgebiete sind die wahrscheinlichsten Gründe für den beobachteten Rückgang in der Verbreitung aller vier Arten.

References

- Albertson N. 1946. Österplana hed. Ett alvarområde på Kinnekulle. Acta Phytogeogr. Suec. 20: I–XII, 1–267.
- Apinis A. and Lacis L. 1936. Data on the ecology of bryophytes II. Acidity of the substrata of Musci. Acta Horti Bot. Univ. Latv. 9/10: 1–100.
- Berg C. und Wiehle W. 1992. Rote Liste der gefährdeten Moose Mecklenburg-Vorpommerns. 1. Fassung. Goldschmidt-Druck GmbH, Schwerin.
- Bergamini A., Peintinger M., Schmid B. and Urmi E. 2001. Effects of management and altitude on bryophyte species diversity and composition in montane calcareous fens. Flora 196: 180–193.
- Bisang I. 1999. Die Verbreitung von Moosen in der Schweiz und in Liechtenstein. II. *Lophozia* subg. *Schistochilopsis*. Haussknechtia Beih. 9: 45–56.
- Bisang I., Geissler P., Müller N., Schnyder N., Schubiger-Bossard C. und Urmi E. 1998. Die Verbreitung von Moosen in der Schweiz und in Liechtenstein. I. Ein erster Einblick. Bot. Helv. 108: 197–216.
- Bisang I. and Hedenäs L. 2000. How do we select bryophyte species for conservation, and how should we conserve them? Lindbergia 25: 62–77.
- Broggi M. F. 1990. Inventaire des bas-marais d'importance nationale en Suisse. Projet mis en consultation. Dept. Fédéral Intérieur, Bern.
- Cortini Pedrotti C. e Aleffi M. 1992. Lista Rossa delle Briofite d'Italia. In: Conti F. et al. (ed.). Libro Rosso delle Piante d'Italia. WWF Italia, Roma: 557–637.
- Düll R. 1987. Rote Liste der in Nordrhein-Westfalen gefährdeten Moose. 2. Fassung. In: Anonymous (ed.). Rote Liste der in Nordrhein-Westfalen gefährdeten Pflanzen und Tiere. 2. Fas-

- sung. Landesanstalt für Ökologie, Landschaftsentwicklung und Forstplanung, Recklinghausen: 3–43.
- ECCB (ed.). 1995. Red data book of European bryophytes. The European Committee for Conservation of Bryophytes, Trondheim.
- Feldmeyer-Christe E., Schnyder N. and Bisang I. 2001. Distributions and habitats of peat mosses, Sphagnum, in Switzerland. *Lindbergia* 26: 8–22.
- Geissler P., Bagutti B., Bisang I., Müller N., Schnyder N., Schubiger-Bossard C. und Urmi E. 2002. Die Verbreitung von Moosen in der Schweiz und in Liechtenstein. III. Ausgewählte Lebermoose. *Herzogia* 15: 191–213.
- Geissler P., Urmi E. und Schnyder N. 1998. Liste der Moose der Schweiz und ihrer Grenzgebiete. In: Schneider H. und Paulsen J. (ed.). Schweizer Botanik CD '98. Botanisches Institut der Universität Basel, Basel.
- Grims F. 1986. Rote Liste gefährdeter Laubmoose (Musci) Österreichs. Grüne Reihe des Bundesministeriums für Gesundheit und Umweltschutz 5: 138–151.
- Grünig A. 1994. Mires and man. Mire conservation in a densely populated country – the Swiss experience. WSL/FNP, Birmensdorf.
- Grünig A. 1997. Erfolgskontrolle Moorschutz Schweiz. In: Wurzach N. B. (ed.). Zehn Jahre Projekt "Wurzacher Ried". Internationale Fachtagung zur Erhaltung und Regeneration von Mooregebieten. Markgraf Verlag, Weikersheim: 155–166.
- Grünig A., Vetterli L. und Wildi O. 1986. Die Hoch- und Übergangsmoore der Schweiz. *Berichte der Eidgenössischen Anstalt für das Forstliche Versuchswesen* 281: 1–62.
- Grüttner A. 1990. Die Pflanzengesellschaften und Vegetationskomplexe der Moore des westlichen Bodenseegebietes. *Diss. Bot.* 157: 1–323.
- Gutersohn H. 1973. Naturräumliche Gliederung. In: Imhof E. (ed.). Atlas der Schweiz. Eidg. Landestopographie, Wabern-Bern, Tafel 78.
- Hangartner R. 1997. Langzeit-Veränderungen der Vegetation und Flora in Übergangsmooren des nordschweizerischen Mittellandes. Diplomarbeit. Universität Zürich, Zürich.
- Hedenäs L. 1989. The genera *Scorpidium* and *Hamatocaulis*, gen. nov., in Northern Europe. *Lindbergia* 15: 8–36.
- Hedenäs L. 1992. The genus *Pseudocalliergon* in northern Europe. *Lindbergia* 16: 80–99.
- Hedenäs L. 1998a. An evaluation of phylogenetic relationships among the Thuidiaceae, the Amblystegiaceae, and the temperate members of the Hypnaceae. *Lindbergia* 22: 101–133.
- Hedenäs L. 1998b. *Hamatocaulis vernicosus*. In: Hallingbäck T. (ed.). *Artfakta*. ArtDatabanken, SLU, Uppsala: 159.
- Hedenäs L. 1999. Altitudinal distribution in relation to latitude; with examples among wetland mosses in the Amblystegiaceae. *Bryobrothera* 5: 99–115.
- Hedenäs L. 2002. Korvgulmossa, *Pseudo-calliergon turgescens*, en spännande mossa i våra kalkrikaste trakter. *Svensk Bot. Tidskr.* 96: 29–40.
- Hedenäs L. (in press). Amblystegiaceae (Musci). *Fl. Neotrop. Monogr.*
- Kooijman A. 1992. The decrease of rich fen bryophytes in The Netherlands. *Biol. Conserv.* 59: 139–143.
- Krusenstjerna E. v. 1945. Bladmossvegetation och bladmossflora i Uppsalatrakten. *Acta Phytogeogr. Suec.* 19: 1–250, Pl. 1–4, map.
- Ludwig G., Düll R., Philippi G., Ahrens M., Caspari S., Koperski M., Lütt S., Schulz F. und Schwab G. 1996. Rote Liste der Moose (Anthoceroophyta et Bryophyta) Deutschlands. *Schriftenreihe Vegetationsk.* 28: 189–306.
- Nebel M. 2001. Amblystegiaceae, Stumpfdeckelmoose. In: Nebel M. und Philippi G. (ed.). *Die Moose Baden-Württembergs*. Bd. 2. Spezieller Teil (Bryophytina II, Schistostegales bis Hypnobryales). Verlag Eugen Ulmer GmbH & Co., Stuttgart (Hohenheim): 282–355.
- Paul H. 1924. *Hypnum turgescens* T. Jensen. Eine systematisch-geographische Studie. *Kryptog. Forsch.* 6: 408–419.
- Raeymaekers G. 2000. Conserving mires in the European Union. Actions co-financed by LIFE-Nature. Office for Official Publications of the European Communities, Luxembourg.
- Schnyder N. 1993. Vorprojekt zur Erfassung von Indikator-Moosen in den Objekten der Bundesinventare der Hoch- und Flachmoore von nationaler Bedeutung. – Im Auftrag des Bundes-

- amtes für Umwelt, Wald und Landschaft (BUWAL). Forschungsstelle für Umweltbeobachtung, Egg.
- Sørensen H. 1948. Studies on the ecology of Danish water- and bog mosses. Dansk Bot. Ark. 12(10): 1–47.
- Touw A. and Rubers W. V. 1989. De Nederlandse bladmossen. Flora en verspreidingsatlas van de Nederlandse Musci (*Sphagnum* uitgezonderd). Natuurhistorische Bibliotheek van de KNNV 50: 1–532.
- Urmi E., Bisang I., Geissler P., Hürlimann H., Lienhard L., Müller N., Schmid-Grob I., Schnyder N. und Thöni, L. 1992. Die gefährdeten und seltenen Moose der Schweiz – Rote Liste. BUWAL, Bern.
- Urmi E. and Schnyder, N. 1996. Puzzle statt Schach. Eine naturräumliche Mosaikkarte der Schweiz und Liechtensteins in digitaler Form. Vierteljahrsschrift der Naturforschenden Gesellschaft in Zürich 141(3): 123–131.
- Urmi E., Schnyder N. and Geissler P. 1990. A new method in floristic mapping as applied to an inventory of Swiss bryophytes. In: Bohn U. and Neuhäusl R. (ed.). Vegetation and flora of temperate zones. SPB Academic Publishing, The Hague: 21–32.
- Vanderpoorten A., Hedenäs L., Cox C. and Shaw A. J. 2002a. Circumscription, classification, and taxonomy of Amblystegiaceae (Bryopsida) inferred from nuclear and chloroplast sequence data and morphology. Taxon 51: 115–122.
- Vanderpoorten A., Hedenäs L., Cox C. and Shaw A. J. 2002b. Phylogeny and morphological evolution of the Amblystegiaceae (Bryopsida). Mol. Phyl. Evol. 23: 1–21.
- Witting M. 1949. Kalciumhalten i några nordsvenska vatten. Svensk Bot. Tidskr. 43: 715–739.
- Zimmerli S. 1988. Vegetation und Standort von Schwingrasen in der Schweiz. Veröffentlichungen des Geobotanischen Instituts Rübel 102: 1–105.