

## **Heading towards a survey of fungi in Bavaria – Josef POELT's contribution to achieving substantial progress**

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**Abstract:** The efforts to establish checklists of fungi in Bavaria are discussed. An impact to achieve results was given by Josef POELT during his employment at the Bavarian Botanical State Collection. Two checklists, of which one deals with the Peronosporales, the other one with the Basidiomycota in their broader sense, are mentioned and explained as examples. The quite recently published checklist of Basidiomycota found in Bavaria lists approximately 4,000 species. The perspectives in respect to further progress are treated. Lack of taxonomic expertise in general is commented on and the species concept of fungi is discussed.

### **1. Introduction**

Prof. Dr. Josef POELT, in whose memory we have come together, was without any doubt one of the most outstanding scientists of his time in the field of cryptogamic organisms, even on an international level (HERTEL & OBERWINKLER 1996; many of the hereinafter presented facts and data are based on the obituary presented by these authors, another note of remembrance was published by BRESINSKY 1995). His contribution to mycology was decisive for the development of this subject in Bavaria and elsewhere.

### **2. Josef POELT in Munich and his first publications**

His outstanding commitment to nature and science had its origin in POELT's love of his native country Bavaria (born 1924), where he lived and worked until his appointment to a full professor at the University of Berlin in 1965. He began his career in Munich as a scientific assistant at Munich Botanical Garden (1951–1954), since 1954 he was a senior curator of the department of cryptogamic organisms within the Botanical State Collection in Munich. In 1958 he was elected head of the Bavarian Botanical Society and from 1959 on he was a habilitated member of the University in Munich where he had previously been a student (1946–1950), obtaining his doctoral degree there. Within the four institutions he was engaged at (Botanical Garden, Botanical State Collection, University, Botanical Society), he worked, conducted research and took care of the units according to his responsibilities. He encouraged young and older persons as well to join him in observing and studying diversity in nature. He offered support and stimulation to all of them. Nowadays visitors of the Botanical Garden of Munich are reminded of the aspiring scientist from the generation of our teachers and our supervisors on a "Josef-POELT-Trail" near the very delightful "Farnschlucht". It is a place where ferns are cultivated

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in abundant magnificence, ferns to which POELT had developed a special affection like to many other plants. It is the place where, as a first record for Central Europe, POELT found the fungus *Woldmaria crocea*, developed on the basal parts of the fronds (rhachis) of the Ostrich Fern, *Matteuccia struthiopteris* (ANGERER & POELT 1960; illustrated at the initiative of POELT in CASPARI et al. 1963). In 1950, the first year of POELT's publications, no less than six (partially brief) communications appeared, one on lichens, two on bryophytes (with one species new for Germany: *Trochobryum carniolicum*; POELT 1950), two on fungi (description of two new species) and one on a flowering plant (new for Bavaria), demonstrating his broad scope of interest and knowledge.

POELT's first mycological publication was focused on a rust fungus developed as an *Aecidium* on Deadly Nightshade, *Atropa belladonna*, as its host plant (PAUL & POELT 1950). Many other contributions on various groups of fungi followed: Laboulbeniales (POELT 1952a, 1952b, STADELMANN & POELT 1962), slime molds (POELT 1956a), lower Basidiomycetes (POELT 1954, 1960, POELT & OBERWINKLER 1962), smut fungi (BOIDOL & POELT 1963), downy mildews (in collaboration with DOPPELBAUR und HUBER; DOPPELBAUR et al. 1965). The slime molds offered POELT a beautiful and much more interesting world of small dimensions and modest appearance compared to those miserable circumstances prevailing in the time of war he just had overcome (his record of *Trichia favoginea* traces back to the year 1947). In case of the minute insect-bound members of Ascomycetes, known as Laboulbeniales (Fig. 1), POELT's attitude became obvious in his giving attention to small, nearly invisible organisms which, nevertheless, exhibit a magnificent diversity. In the survey established by him (STADELMANN & POELT 1962), 170 different species of Laboulbeniales are listed for Central Europe, together with the insects serving as substrates; many of the fungal species were identified in POELT's own work, some of them recorded for Germany and also for Bavaria (8 species from Bavaria are mentioned in POELT 1952a, 1952b, including the new species *Laboulbenia buehlmannii* POELT).

On his path of scientific work, teaching and offering stimulation to other people around him, within a remarkable short period of eleven years as a staff member of the Botanical State Collection in Munich, he nevertheless set milestones for sustainable developments of various fields, especially in Lichenology and Mycology. In his almost unsurpassable versatility, he also worked on other groups of organisms without losing a critical attitude. His doctoral thesis deals with associations of bryophytes, and he repeatedly reported on rare or overlooked species of mosses. He also contributed to the taxonomy within critical groups of vascular plants on the species level (inter alia *Alchemilla*) and supervised studies on vegetation patterns in remarkable areas of Bavaria.

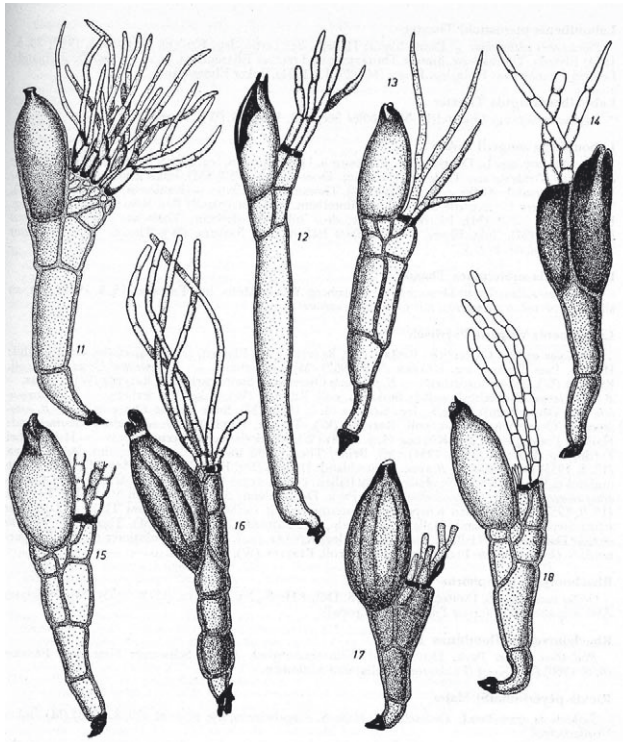


Fig. 1: Different species of *Laboulbenia* drawn by Manfred STADELMANN taken from STADELMANN & POELT 1962. – *Laboulbenia brachyata* THAXT. (11); *L. caprae* COLLA (12); *L. europaea* THAXT. (13); *L. nebriae* PEYR. (14); *L. elongata* THAXT. (15); *L. proliferans* THAXT. (16); *L. parvula* THAXT. (17); *L. polyphaga* THAXT. (18).

The interaction and collaboration of outstanding persons in leading positions, Hermann MERXMÜLLER on the one hand as the director of the Botanical State Collection and full professor (“Ordinarius”) of the University Institute of Systematic Botany, and on the other hand of Josef POELT in his previously mentioned functions, were both a challenge as well as an encouragement and substantial support for employees and students. It was a nearly unique constellation of leading and teaching scientists, including also Karl MÄGDEFRAU, who at that time was full professor (“Extraordinarius”) in the same building until his departure to Tübingen University in 1960. The collaboration of MERXMÜLLER and POELT gets evident from a number of publications, such as the study on the floral history of the Alps, in which cryptogamic organisms, too, were considered in particular by POELT (MERXMÜLLER & POELT 1954). It is also visible in the annually published series “Fortschritte der Botanik” (Progress in Botany) with reports on angiosperms given by MERXMÜLLER and on lichens, bryophytes and pteridophytes contributed by POELT (e.g. POELT 1955a, 1955b, 1956b). In regard to the high number of publications from various groups of organisms which had to be studied and evaluated, it certainly was a tremendous effort based on a profound knowledge of the existing literature in this field.

A person showing such intensive creative work, with such a nearly unbelievable capability of drudgery, gifted with outstanding capacities of observing, understanding and evaluating was certainly qualified for higher ranked

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positions. So his time in Munich came to an end since he was subsequently appointed to professorships at the universities of Berlin and Graz. In his observational attitude, he predominantly focused on the small and inconspicuous phenomena to which he devoted himself with persevering dedication and great concentration. On field trips he did so as well, without regarding the passing of time and without consideration of only superficially interested companions. However, really interested participants received great benefits from his way of intensive observation and frankly given instructions. During his time in Munich he already supervised a number of scientific studies and among them seven doctoral theses (listed in HERTEL & OBERWINKLER 1996). Some of his former students had a successful scientific career, educating students themselves. Thus, the passion for scientific work has been passed on from one generation to more than one of the next ones. How could success in higher academic education be measured differently or even better?

### **3. Survey of diversity within selected groups of fungi in Bavaria**

Assembling far-spread individual contributions in an overview, as was done by POELT for Central European Laboulbeniales (Fig. 1), is another integrative step that he intended to take for parasitic fungi in Bavaria. He would have surely accomplished this if he had stayed in Munich longer. With his departure his work focused on other geographic regions. However, what remained was his encouragement for all those people of his former entourage whom he left behind to continue the work in the region and not to lose sight of this goal. Two examples will be given here.

Hans DOPPELBAUR elaborated, in cooperation with some other researchers, a carefully established inventory of downy mildews (Peronosporales, Oomycota) occurring in Bavaria. DOPPELBAUR (DOPPELBAUR & DOPPELBAUR 1972) expressively mentions the fact that it was POELT who suggested that he should deal with those fungi and accomplish such an enterprise (Fig. 2). The result is a list of 186 species recorded with their different hosts (DOPPELBAUR et al. 1965, DOPPELBAUR & DOPPELBAUR 1968, 1972, 1974). In regard to complete registration, the level reached can be considered quite a good result, taking the new list of Saxonia with 161 species (HARDTKE et al. 2015) into account. Nevertheless, there are still considerable gaps to be filled in future. Downy mildews on cultivated plants or on trees were not in the focus of observation at that time and therefore were not listed, except for few exemptions. At present infection by different species of *Phytophthora* (JUNG & BLASCHKE 1996, 2003) seems to become an increasing problem (*Phytophthora alni* on *Alnus*, *P. quercina* on *Quercus*, *P. cambivora* and *P. citricola* on *Fagus*, *P. pseudosyringae* inter alia on *Carpinus*). It is an urgent demand to consider and evaluate all contributions dealing with those organisms published in the context of phyto-

pathology. If these DNA-based studies were taken into account, the number of species to be mentioned in a checklist of Oomycota would considerably increase.

At the end of his professional career Helmut BESL, in collaboration with BRESINSKY (BESL & BRESINSKY 2009), took up POELT's suggestion and developed a checklist for Basidiomycota s.l. occurring in Bavaria. Very helpful for establishing the list were various already existing and more recently published surveys of some subgroups, presented e.g. by SCHOLZ and SCHOLZ 1988 (Ustilaginales) or BRANDENBURGER 1994 (Pucciniales). How much the new checklist integrates results

of POELT and his students can be easily demonstrated with various examples: e.g. for the Pucciniomycotina *Puccinia paulii* POELT on *Arabis bellidifolia*, for the Ustilaginomycotina diverse species of *Ustanciosporium* on *Rhynchospora alba*, for the Agaricomycotina *Suillus sibiricus* subsp. *helveticus* (Fig. 3) or *Mycolindtneria trachyspora* and many other cases where POELT contributed to the knowledge of fungi occurring in Bavaria.

The checklist features for each listed species the accepted name with full citation of the authors, the most important synonyms, the occurrence in the individual regions of Bavaria, data as to maximum altitude of occurrence in case of records from the Alps or from the lower mountain ranges, the host plants of fungal parasites, and if available historical interpretive documents in the form of pictures in classical works (e.g. in SCHAEFFER 1762–1774, BRITZELMAYR 1879–1897), published references to younger records, identification-numbers of existing specimens in the herbaria of Munich (M) and Regensburg (REG), type locality for species primarily described from the region of Bavaria, status in the red list of endangered species (according to KARASCH & HAHN 2009) and finally in some cases comments on taxonomy. Integrated into the



Fig. 2: Meeting at Whitsuntide (in May 1950) at Lecheng near Illasberg north of Füssen (Bavaria). From left to right: Josef POELT, Oscar KLEMENT, Hans DOPPELBAUR.

Josef POELT found by occasion of this meeting *Trochobryum carniolicum* BREIDL. & BECK as a new record for Germany (POELT 1950); in the same year he obtained his doctor degree (PhD). Oscar KLEMENT (later honored by the title Dr. h. c.) was an amateur expert in lichens. Hans DOPPELBAUR obtained his doctor title (PhD) on behalf of a study on endolithic lichens and worked on parasitic fungi (Peronosporales) following a suggestion given by POELT. Photo: Heinz FISCHER in the photo collection of A. BRESINSKY.

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references are monographic studies of fungi, which were initiated by the author of this paper, e.g. regarding the national parks in the Alps of Berchtesgaden (SCHMIDT-HECKEL 1985), in the Bavarian Wood (LUSCHKA 1993), the biosphere reservation Rhön (KRIEGLSTEINER 2004). A number of publications in the Bavarian Mycological Journal (Bayerische Mykologische Zeitschrift), in the Reports of the Bavarian Botanical Society (Berichte der Bayerischen Botanischen Gesellschaft) and in the Mycological Journal of the Botanical Society of Regensburg (Regensburger Mykologische Schriften) were also included in this evaluation (e.g. BLASCHKE 2005, KRIEGLSTEINER 1999).



***Suillus sibiricus* subsp. *helveticus* Singer 1951 [1949]**

= *Ixocomus sibiricus* sensu Favre 1945

Region: A (1870 m)

Lit.: POELT in ANGERER & POELT (1960: 7); SCHMID-HECKEL (1985: 103, als *S. sibiricus*)

Herb.: REG 819 (als *S. sibiricus*)

RL Bayern: R

Anm.: Nach SINGER (1965) kommt *S. sibiricus* (Singer 1938) Singer 1945

subsp. *sibiricus* nicht in Mitteleuropa vor.

PILZOEK - <http://www.pilzoek.de/> - Online-Datenbankabfrage:

*Suillus sibiricus* Sing. 16 Einträge (hier in Auswahl): Ernährungsweise: Mykorrhiza-Symbiont (1026).- Substrate: *Pinus cembra*, *Pinus sylvestris* (1026, 1046, 1143, 1152). Bindung an Formationen, Gesellschaften, Standorte: Subalpine Lärchen-Arven-/Lärchenwälder, Arve dominierend (1011, 1012, 1188, 1046). *Vaccinio-Pinetum cembrae* (1011, 1012, 1046). *Dicrano-Pinion* (1011, 1012). Gefährdung und Verbreitung in Deutschland: subalpin (1046). Alpen (1012, 1046). Bayern (1012, 1046). Allgemeine Verbreitung: Bulgarien(1143); Deutschland (1026); Frankreich ohne Korsika (1188) Mazedonien (1152); Schweiz (1011). Quellen: 1011: Horak 1963; 1012: Schmid-Heckel 1985; 1046: Bresinsky 2000; 1152: Tortic 1968; 1026: Wöllecke 2001; 1143: Dörfelt & MÜSCH 1987; 1188: Bon & Gehu 1973.

Fig. 3: Following the examples and suggestions given by POELT, a check list of Basidiomycota in Bavaria has been elaborated by BESL and BRESINSKY (2009). The list includes also a number of records published by POELT (f. e. *Suillus sibiricus* subsp. *helveticus*). Attention has been paid among others to the occurrence in different regions (f. i. A = Alps). For many species mentioned in the check list ecological and geographical data are available for retrieval from the data base PILZOEK (<http://www.pilzoek.de/>). An example is given here for *Suillus sibiricus*.

Detailed ecological information was not considered in the checklist. An attempt at also recording in detail the ecological parameters of each species was started by establishing the database “PILZOEK” ([www.pilzoek.de](http://www.pilzoek.de); BRESINSKY et al. 2005). With the help of this database, it is possible to retrieve geographic and ecological information for many species mentioned in the checklist.

In the checklist of the Basidiomycota of Bavaria a total of approximately 4,000 species are listed. Due to its (albeit small) share of the Alps and because of quite different types of landscapes, Bavaria is probably the federal state with the greatest diversity of species in Germany. The total number of species, considering all fungal organisms of different phylogenetic relationship, should be extrapolated to no less than 10,000 (BRESINSKY 2010).

#### **4. Partial results and problems on the way to establishing further surveys**

The share of 6,000 species left for justifying the estimated total species number of 10,000 should predominantly come from the so far insufficiently investigated Ascomycota and “Deuteromycota”. Within the former group only the species with more or less conspicuous fruit bodies have received more attention (e.g. through STANGL 1968, FELLMANN 2014, FELLMANN & ESTERLECHNER 2014) as compared to the other ones. An exemption in this context is certainly the intensively investigated fungal parasites on lichens with about 400 species recorded in Bavaria (v. BRACKEL 2014). This extraordinary study has its roots in a first impulse given by POELT. A critical inventory of Ascomycota and “Deuteromycota” of Bavaria in a commented checklist has to consider the extensive amount of publications from the past (e.g. contributions to the knowledge of bryicolous Ascomycetes; DÖBBELER & POELT 1974), the specimens deposited in the Botanical State Collection in Munich and recently published studies as well. It remains a tremendous task, which can only be accomplished in collaboration of scientists with amateurs. However, in both groups there is a lack of trained persons who are devoted to studying diversity of fungi.

Except for the Basidiomycota, the Myxomycota and part of the Oomycota (Peronosporales), fungi (like the Ascomycota) have not received enough attention yet in order to establish a survey of their species diversity in Bavaria. One reason for this obstacle is the lack of manpower and diminishing taxonomic expertise.

#### **5. Complaints about diminishing taxonomic expertise**

In a paper on the downy mildew species *Plasmopara angustiterminalis*, recorded for the first time in Central Europe (Austria, Burgenland; introduced

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as an invading species on *Xanthium* from North America), POELT and REMLER (1977) complain about the dwindling interest in field observation of parasitic fungi. The number of persons interested in parasitic fungi has fallen continuously, at least in Germany. Although the rust fungi are fortunately receiving more attention again, a glimpse into the past reveals a great decrease in taxonomic expertise for many groups of organisms, on a general level and for fungi with missing or inconspicuous fruit bodies especially. Thus POELT's complaints are still justified nowadays. The dramatic situation gets evident, if we consider, for example, that in the 19<sup>th</sup> century internationally well-known authorities were intensively and successfully studying groups of fungi which nowadays are neglected to a considerable extent. The fact that the Ascomycota and the Deuteromycota within the voluminous "Kryptogamenflora" of RABENHORST were treated by experienced amateurs, a medicinal doctor and a teacher in Munich (REHM 1896, ALLESCHER 1901, 1903) is proof of this statement; in their work many citations of species records refer to Bavaria.

The present lack of taxonomic expertise in those fungal groups contradicts their high diversity in nature and their meaningful ecological interrelationships. As a matter of fact, there is a great demand for critical attention in regard to taxonomy on the species level, occurrence, spread and ecological data.

## 6. Comments on the species concept in fungi

Checklists are inevitably dependent on the accepted species concept. In practical application a species is a unit considered by a good field mycologist (or in a broader sense a taxonomist) as being a species of its own. That does not mean that the door would be open for arbitrariness. Regarding this issue, POELT expressed his opinion in his own words using the German word "taugen". This means, a species should be qualified in the sense that it has to be clearly recognizable (also by other observers) as a unit of its own without (or nearly without) showing transitions to other related species and without comprising subunits of comparable quality. The discriminating features should not simply depend on environmentally induced modificatory variation. The quality of a species depends on genetic differences to closely related other ones and on genetically or otherwise established isolation mechanisms limiting any gene flow. Nowadays genetically based differences can be measured by the modern techniques of gene sequencing. We do not know whether POELT would have appreciated these new possibilities of investigation. At least he would have preserved his own critical view of the application of new techniques. The results depend on the precise identification of the investigated species, on the suitable selection of samples, on the sequenced part (domain) of genes, and last but not least, on accurately performed laboratory work.



Evidence of genetic isolation is given by crossing experiments and, in case of parasitic fungi, by crosswise performed infection experiments. Crossing experiments will only be performable in limited number because of the tremendous species diversity in fungi and because of difficulties in obtaining single-spore-cultures in general. With the help of examples within the genera *Pleurotus* and *Phellinus* s.l. it could be demonstrated in Regensburg that the empirical species concept (i.e. definition of species by observation) mostly matches the results well which are obtained from crossing experiments in the laboratory (e.g. *Pleurotus pulmonarius* versus *P. ostreatus*; *Phellinus robustus* versus *P. hartigii*; HILBER 1982, FISCHER 1987). The results are supported by DNA-analyses, including cladistical evaluations, and the assumption of polyploidy based on comparative quantitative measurements of nuclear DNA-contents (e.g. *Pleurotus*: BRESINSKY et al. 1987a, 1987b, GONZALEZ & LABARÉRE 2000, BAO et al. 2005).

In case of two quite similar species of *Boletus*, *B. edulis* versus *B. pinophilus*, which had been included by POELT and his collaborators (CASPARI et al. 1963) in the marvelously illustrated book dealing with Central European fungi, the concept of different species could subsequently be proved by using methods of DNA-analysis (JAROSCH 2000, LEONARDI et al. 2005).

On the other hand, *Leccinum* (Boletaceae) still remains a genus with problems on the species level. Whereas some of the species are clearly supported by the available DNA data (*L. flavostipitatum* and *L. variicolor* against *L. holopus* and *L. scabrum*), others are not (*L. nucatum* and *L. molle* against *L. holopus*; BINDER 1999) and should be treated as synonyms. The species to be rejected only depend on unreliable discriminating characters of slight color variation, a fact that could be (or even has been) proved by thoroughly undertaken observations in the field.

A point has been reached where field work seems to be substituted more and more by biochemical laboratory work. However, research on biodiversity still remains absolutely dependent on intensive and critical observation of the phenomena in the field, as it was done by POELT in a most admirable mode during his lifetime.

Without the inspiring influence of Josef POELT, in his time of working in Berlin and Graz, too, interesting fields of research would not have been promoted to at least preliminary results. To Regensburg, with its unique history, its traditional old Botanical Society (from 1790) and its comparatively new university, he remained in steady affiliation even from a distance. He was appointed president of the International Mycological Congress hosted in Regensburg in 1990. He was honored with this position because of his international reputation as a leading scientist. In the course of this event he presented a general lecture on a topic reaching far beyond regional species diversity of

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fungi. His lecture concentrated on the field of his main interest, the lichenized fungi, evaluating their analogies and homologies (POELT 1991).

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## 8. Author citations of species names mentioned in the text

*Arabis bellidifolia* CRANTZ. — *Atropa belladonna* L. — *Boletus edulis* BULL.: FR. — *Boletus pinophilus* PILÁT & DERMEK. — *Laboulbenia buehlmannii* POELT. — *Leccinum flavostipitatum* E.A. DICK & SNELL. — *Leccinum holopus* (ROSTK.) WATLING. — *Leccinum molle* (BON) BON. — *Leccinum nucatatum* LANNOY & ESTADÈS. — *Leccinum scabrum* (BULL.: FR.) GRAY. — *Leccinum variicolor* WATLING. — *Matteuccia struthiopteris* (L.) TOD. — *Mycolindtneria trachyspora* (BOURDOT & GALZIN) RAUSCHERT. — *Phellinus hartigii* (ALLESCH. & SCHNABL) BONDARTSEV. — *Phellinus robustus* (P. KARST.) BOURDOT & GALZIN. — *Phytophthora alni* BRASIER & S.A. KIRK. — *Phytophthora cambivora* (PETRI) BUISMAN. — *Phytophthora citricola* SAWADA. — *Phytophthora pseudosyringae* T. JUNG & T.I BURGESS. — *Phytophthora quercina* T. JUNG & T.I BURGESS. — *Plasmopara angustiterminalis* NOVOT. — *Pleurotus ostreatus* (JACQ.: FR.) P. KUMM. — *Pleurotus pulmonarius* (FR.: FR.) QUÉL. — *Puccinia paulii* POELT. — *Rhynchospora alba* (L.) VAHL. — *Suillus sibiricus* (SINGER) SINGER subsp. *helveticus* SINGER. — *Trichia favoginea* (BATSCH) PERS. — *Trochobryum carniolicum* BREIDL. & BECK. — *Woldmaria crocea* (P. KARST.) W.B. COOKE.

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