Calicioid Lichens and Fungi in the Muota Valley, Central Switzerland: High Species Diversity in a Small Area

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Source: Candollea, 65(2) : 377-391

Published By: The Conservatory and Botanical Garden of the City of Geneva (CJBG)

URL: https://doi.org/10.15553/c2010v652a17

Calicioid lichens and fungi in the Muota Valley, central Switzerland: high species diversity in a small area

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Abstract

GRONER, U. (2010). Calicioid lichens and fungi in the Muota Valley, central Switzerland: high species diversity in a small area. *Candollea* 65: 377-391. In English, English and French abstracts.

An inventory of the calicioid lichens and fungi of the Bödmeren Forest region in the Muota Valley, central Switzerland, produced no less than 51 lichenized and non-lichenized taxa on bark and wood. This mainly subalpine spruce forest in the Prealps hosts the most diverse calicioid flora in Switzerland today and a similarly rich flora from a comparably small area is unknown from neighbouring countries. *Calicium denigratum* (Vain.) Tibell and *Chaenothecopsis oregana* Rikkinen are new to Switzerland. *Calicium adaequatum* Nyl., *Chaenothecopsis tasmanica* Tibell and *Chaenothecopsis vainioana* (Nádv.) Tibell are also reported for the first time from this region. *Chaenotheca chrysocephala* (Ach.) Th. Fr., *Calicium viride* Pers., *Chaenotheca trichialis* (Ach.) Th. Fr. and *Microcalicium disseminatum* (Ach.) Vain. are the most frequent species, the majority of the other taxa are uncommon or rare. The diversity of the calicioid (and other) species is due to several favourable conditions, such as the presence of old-growth forest stands and the occurrence of standing dead trees. More than 40% of the recorded lichenized calicioid taxa are threatened; the state of the poorly known non-lichenized calicioids is undetermined as they were not evaluated in the "Red List".

Key-words

ASCOMYCOTA – Calicioid lichens and fungi – Floristics – Conservation – Muota Valley – Swiss Prealps

Résumé

GRONER, U. (2010). Lichens et champignons calicioides dans la vallée de la Muota, Suisse centrale: une grande diversité d'espèces sur un petit territoire. *Candollea* 65: 377-391. En anglais, résumés anglais et français.

Un inventaire des lichens et des champignons calicioides épiphytiques et lignicoles a été conduit dans la région du Bödmerenwald, vallée de la Muota. Dans cette forêt d'épicéa principalement subalpine, située dans les Préalpes en Suisse centrale, on a recensé 51 espèces lichenisées et non-lichenisées, ce qui en fait à ce jour la flore calicioide connue la plus diversifiée de Suisse. Dans les pays voisins, aucune région comparable ne possède une flore aussi riche. *Calicium denigratum* (Vain.) Tibell et *Chaenothecopsis oregana* Rikkinen sont des espèces nouvelles pour la Suisse. De plus, *Calicium adaequatum* Nyl., *Chaenothecopsis tasmanica* Tibell et *Chaenothecopsis vainioana* (Nádv.) Tibell sont de même mentionnés pour la première fois de cette région. *Chaenotheca chrysocephala* (Ach.) Th. Fr., *Calicium viride* Pers., *Chaenotheca trichialis* (Ach.) Th. Fr. et *Microcalicium disseminatum* (Ach.) Vain. sont les espèces les plus fréquentes, alors que la majorité des autres taxons sont peu communs ou rares. La diversité des taxa calicioides (et d'autres espèces) est due à plusieurs facteurs favorables, comme des reliques de forêt vierge et la présence de troncs morts érigés. Plus de 40% des espèces calicioides lichenisées de la région sont menacées; le statut des espèces non-lichenisées, peu étudiées, n'est pas connu car elles ne sont pas considérées dans la «Liste Rouge».

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Submitted on July 9, 2009. Accepted on October 26, 2010.

Edited by P. Bungener

ISSN: 0373-2967 *Candollea* 65(2): 377-391 (2010)

Introduction

The knowledge about calicioid lichens and fungi (the "Caliciales") in Switzerland went relatively unchanged for a long period of time. Only a few references are cited by CLERC (2004) for the lichenized genera, such as the pin-lichens *Calicium* Pers., *Chaenotheca* Th. Fr., etc., between about 1940 and 1980. In the 1990s, only two noteworthy contributions, the works of CAMENZIND & WILDI (1991) and GRONER (1994), were published. Data were gathered, mainly of the lichenized calicioid species, during field work for the "Red List of epiphytic lichens" (SCHEIDEGGER & al., 2002). Shortly after that, the pertaining distribution maps were available on "swisslichens" (STOFER & al., 2008). Stimulated by the checklist of CLERC (2004) and by the periodically updated results on the cited web site, descriptions of new discoveries have steadily increased (BÜRGI-MEYER, 2005; DIETRICH & al., 2008; DIETRICH & BÜRGI-MEYER, 2008b; ZIMMERMANN, 2009), as well as reports about additional localities of rare taxa (BÜRGI-MEYER, 2007; DIETRICH & BÜRGI-MEYER, 2008a).

The region of the Bödmeren Forest in the Muota Valley in central Switzerland has been described as lichenologically very interesting and species-rich (GRONER & CLERC, 1988; GRONER, 1990, 1997). Data regarding calicioid lichen and fungus species, however, have only recently been published within the scope of the project "Urwaldcharakteristiken des Bödmerenwaldes" (GRONER & FREI, 2005; STIFTUNG URWALDRESERVAT BÖDMEREN, 2005). This recent work on calicioid taxa, together with the wealth of the calicioid flora in the region, were inspiration for an overview of the genus *Chaenothecopsis* Vain. for the whole of Switzerland (GRONER, 2006). The current paper is part of a long-term project, the lichen inventory of the wider Bödmeren Forest area. All calicioid taxa are treated in an annotated list, and the substrates, frequencies of the species and threats are discussed. *Calicium denigratum* (Vain.) Tibell, collected in 2007 and *Chaenothecopsis oregana* Rikkinen, collected in 2003, are reported here for the first time from Switzerland.

Study area

The Bödmeren Forest and its surroundings in the Muota Valley (municipality of Muotathal, canton of Schwyz) including the primeval forest reserve of ca. 70 ha, is probably the scientifically best documented region of the northern Prealps in Switzerland (Fig. 1). It has been described in numerous papers with geological, botanical and zoological content; most of these contributions were published in BETTSCHART (1982, 1990, 1994) and LIENERT (2001). The area of Bödmeren-Twärenen-Silberen is part of the largest contiguous karst in the country. High annual precipitation and long periods of snow cover are characteristics of the regional climate. However, no substantial surface water

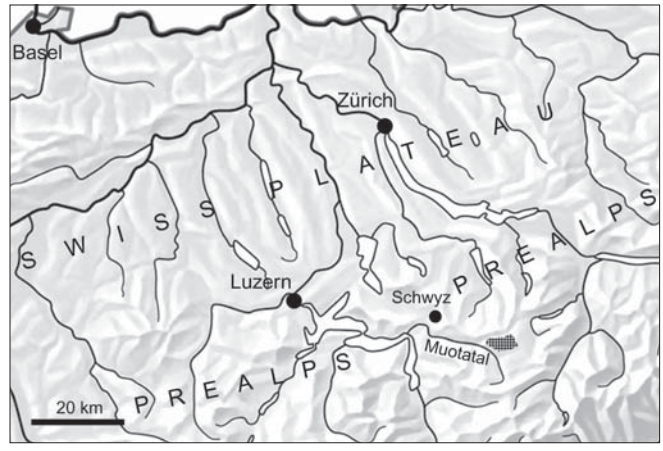

Fig. 1. – Location of the study area in the northern Prealps of Switzerland.

is present because of the subterranean drainage. The forested karst includes the montane-high montane and the subalpine zone, and as might be expected given the geological conditions, the vegetation is predominantly calciphile. A spruce-dominated *Abieti-Fagetum* is developed at lower altitudes; the larger part, however, is covered by a locally dispersed *Piceetum subalpinum* and cattle pastures. The study area of ca. 14 km^2 more or less corresponds to the area described in GRONER (1990). It includes the forested terrain between the altitudes of 1100 m in the west and about 1800 m in the east, with the Bödmeren Forest in the centre. Its boundaries mostly follow the topographical conditions except for the western delimitation.

Material and methods

The current paper is based on numerous field observations and more than 100 specimens of calicioid species, collected on many excursions during the last 24 years. Part of the data – from the Bödmeren Forest s.str. – originates from the above mentioned project (GRONER & FREI, 2005). The specimens were analyzed under dissecting binoculars and a light microscope. The keys of L. Tibell (in POELT & VEZDA, 1981), TIBELL (1999a) and WIRTH (1995) were used for determination. The work of TITOV (2006) includes modern keys and descriptions of the non-lichenized genera. Reagent tests were performed on the thalli and ascomata of several lichenized taxa; such tests, mainly with K (10% KOH) and N (50% HNO_3), are necessary for the separation of *Chaenothecopsis* taxa. Overall descriptions of genera and species are given in the cited literature, but some morphological, anatomical and chemical features, especially the criteria for separating similar species, are mentioned in the list. The species with stalks may have branched ascomata and/or divided (multiple) capitula (Fig. 14, 16). Size, colour or pruina may vary and differ from the descriptions given in the literature (Fig. 6, 15, 19). Pale hyphae on a stalk or capitulum (Fig. 19), or colourless paraphyses

growing out of a mazaedium, may possibly be mistaken for pruina. Accumulations of mature spores are sometimes observed on capitula without a mazaedium (e.g. *Mycocalicium subtile* (Pers.) Szatala). L. Tibell determined or revised some of the cited specimens; the resinicolous *Chaenothecopsis oregana* was examined by J. Rikkinen and H. Tuovila.

All calicioid genera belong to *Ascomycota*. The nomenclature adopted here for the lichenized species (Table 1) follows Clerc (2004). Taxa not considered in that work, and the non-lichenized species, are named as in Tibell (1999a, b) and Titov (2006), respectively. Altitudes mentioned in the table correspond to the lowest and the highest collection locality. Multiple occurrences (i.e. on 2 to 5 tree trunks) at a test site in Groner & Frei (2005) are treated as one record (observed frequency, Table 1). Only modern information about species frequencies in Switzerland from Stofer & al. (2008) is cited. Data of *Chaenothecopsis* are taken from Groner (2006). The categories of threat ("Red List" category) "CR" (critically endangered), "EN" (endangered) and "VU" (vulnerable) are added for the lichenized taxa included in Scheidegger & al. (2002). Collection data will be available on Stofer & al. (2008). All specimens were collected by the author and are deposited in the author's herbarium. The photographs were taken of recently collected herbarium material, exceptions are mentioned in the figure legends; the cited numbers are specimen (herbarium) numbers.

Results

Comments on the species listed in Table 1.

1. *Calicium abietinum*

The documented collections in Switzerland (Stofer & al., 2008) are epiphytic; the lignum of conifers, the common habitat of *C. abietinum,* has obviously not been investigated so far. In the field confusion possible with *C. pinastri* (see below).

2. *Calicium adaequatum*

All Swiss observations of this species on twigs of sycamore, in contrast to the substratum information from northern Europe (Tibell, 1999a). Stalk and excipulum Iodine + violet to dark blue. The thalli of all examined specimens are not immersed as mentioned in Tibell (1999a), but instead have warty to almost squamulose, greenish grey areoles (Fig. 2). Photobiont trebouxioid.

3. *Calicium adspersum*

Collections on the Swiss Plateau on oak; in the upper montane and subalpine belts mainly of the northern Prealps, on conifers. Mazaedium with more or less faint yellow pruina. Thallus usually distinct, K+ red (see *C. trabinellum).*

Fig. 2. – *Calicium adaequatum* Nyl., thallus warted-areolate (*Groner 2884,* herb. Groner). Scale = 1 mm.

4. *Calicium denigratum*

The collection locality of *C. denigratum* is in an open *Piceetum subalpinum* with scattered mountain pines; on dry wood of a standing dead trunk (12 cm diam.). The lichen covers an area of about 3 dm^2, it is accompanied by *Calicium trabinellum.* Small thalli of *Imshaugia aleurites* (Ach.) S. L. F. Mey., *Parmeliopsis ambigua* (Wulf.) Nyl. and *Buellia griseovirens* (Sm.) Almb. present as well (collection date: October 3, 2007). Thallus of *Calicium denigratum* immersed; ascomata of the specimen mostly slender, without pruina, the stalks glossy black; capitula cup- to bell-shaped (Fig. 3, 4). Asci cylindrical, the spores uniseriately arranged, 1-septate; mature spores with irregular pattern of cracks, therefore the surface appearing areolate. The mentioned characteristics correspond with the description in Tibell (1999a). This *Calicium* species is distinct and hardly confusable with any other taxon.

Fig. 3. – *Calicium denigratum* (Vain.) Tibell (*Groner 3135,* herb. Groner). Scale = 1 mm.

Table 1. – List of the calicioid lichens and fungi of the Bödmeren Forest area. The rarer cases under "Host" and "Substrate" are set in brackets.

Species		Life strategy	Host
1.	*Calicium abietinum* Pers.	lichenized	
2.	*Calicium adaequatum* Nyl.	lichenized	
3.	*Calicium adspersum* Pers.	lichenized	
4.	*Calicium denigratum* (Vain.) Tibell	lichenized	
5.	*Calicium glaucellum* Ach.	lichenized	
6.	*Calicium lenticulare* Ach.	lichenized	
7.	*Calicium montanum* Tibell	lichenized	
8.	*Calicium pinastri* Tibell	lichenized	
9.	*Calicium salicinum* Pers.	lichenized	
10.	*Calicium trabinellum* (Ach.) Ach.	lichenized	
11.	*Calicium viride* Pers.	lichenized	
12.	*Chaenotheca brachypoda* (Ach.) Tibell	lichenized	
13.	*Chaenotheca brunneola* (Ach.) Müll. Arg.	lichenized	
14.	*Chaenotheca chrysocephala* (Ach.) Th. Fr.	lichenized	
15.	*Chaenotheca ferruginea* (Sm.) Mig.	lichenized	
16.	*Chaenotheca furfuracea* (L.) Tibell	lichenized	
17.	*Chaenotheca gracilenta* (Ach.) Mattsson & Middelb.	lichenized	
18.	*Chaenotheca hispidula* (Ach.) Zahlbr.	lichenized	
19.	*Chaenotheca laevigata* Nádv.	lichenized	
20.	*Chaenotheca phaeocephala* (Turner) Th. Fr.	lichenized	
21.	*Chaenotheca sphaerocephala* Nádv.	lichenized	
22.	*Chaenotheca stemonea* (Ach.) Müll. Arg.	lichenized	
23.	*Chaenotheca subroscida* (Eitner) Zahlbr.	lichenized	
24.	*Chaenotheca trichialis* (Ach.) Th. Fr.	lichenized	
25.	*Chaenotheca xyloxena* Nádv.	lichenized	
26.	*Chaenothecopsis consociata* (Nádv.) A. F. W. Schmidt	parasitic/parasymbiotic	*Chaenotheca chrysocephala*
27.	*Chaenothecopsis debilis* (Sm.) Tibell	saprobic	
28.	*Chaenothecopsis epithallina* Tibell	parasitic/parasymbiotic	*Chaenotheca trichialis*
29.	*Chaenothecopsis hospitans* (Th. Fr.) Tibell	parasitic/parasymbiotic	*Lecanora albella* (Pers.) Ach., *L. carpinea* (L.) Vain.
30.	*Chaenothecopsis nana* Tibell	saprobic	
31.	*Chaenothecopsis oregana* Rikkinen	resinicolous	
32.	*Chaenothecopsis parasitaster* (Bagl. & Carestia) D. Hawksw.	parasitic	*Cladonia digitata* (L.) Hoffm.
33.	*Chaenothecopsis pusilla* (Ach.) A. F. W. Schmidt	saprobic ; parasitic	calicioid lichens
34.	*Chaenothecopsis pusiola* (Ach.) Vain.	parasitic/parasymbiotic	*Chaenotheca xyloxena*, (*C. trichialis*), algae
35.	*Chaenothecopsis savonica* (Räsänen) Tibell	parasitic/parasymbiotic	algae, crustose lichens
36.	*Chaenothecopsis tasmanica* Tibell	parasitic/parasymbiotic	*Chaenotheca chrysocephala, C. stemonea*
37.	*Chaenothecopsis vainioana* (Nádv.) Tibell	parasitic/parasymbiotic?	*Lecanactis abietina* (Ach.) Körb.
38.	*Chaenothecopsis viridialba* (Krempelh.) A. F. W. Schmidt	saprobic ; parasymbiotic?	*Chaenotheca chrysocephala*
39.	*Chaenothecopsis viridireagens* (Nádv.) A. F. W. Schmidt	parasitic/parasymbiotic	algae, crustose lichens
40.	*Cyphelium inquinans* (Sm.) Trevis.	lichenized	
41.	*Cyphelium karelicum* (Vain.) Räsänen	lichenized	
42.	*Cyphelium lucidum* (Th. Fr.) Th. Fr.	lichenized	
43.	*Cyphelium tigillare* (Ach.) Ach.	lichenized	
44.	*Microcalicium disseminatum* (Ach.) Vain.	parasitic ; saprobic	calicioid lichens
45.	*Mycocalicium subtile* (Pers.) Szatala	saprobic	
46.	*Phaeocalicium compressulum* (Szatala) A. F. W. Schmidt	saprobic or parasitic	
47.	*Sphaerophorus globosus* (Huds.) Vain.	lichenized	
48.	*Sphaerophorus melanocarpus* (Sw.) DC.	lichenized	
49.	*Sphinctrina anglica* Nyl.	parasitic/parasymbiotic	*Protoparmelia hypotremella* van Herk, Spier & V. Wirth
50.	*Stenocybe major* Körb.	saprobic or parasitic	
51.	*Thelomma ocellatum* (Körb.) Tibell	lichenized	

Frequencies are given on a rough relative scale (absolute numbers in brackets).

Substrate	Altitude [m]	Observed frequency	Frequency in Switzerland	Red List category
wood, *Picea abies* (L.) H. Karst.; bark, *Pinus mugo* Turra	1340-1500	very rare (2)	rather rare	
twigs, *Acer pseudoplatanus* L.	1250-1595	rare (5)	very rare	**EN**
bark, (wood), *Picea* A. Dietr.; (bark, *Abies alba* Mill.)	1275-1580	frequent (49)	on Plateau: rare, Prealps: rather frequent	**VU**
wood, *Pinus* L.	1500	very rare (1)	very rare	not evaluated
bark, *Picea*	1460-1490	rare (3)	rather frequent	
wood, *Picea*	1380-1500	rare (4)	rather rare	**VU**
bark, wood, *Picea,* conifers	1200-1640	rather frequent (27)	rather frequent	
wood, *Picea*	1280	very rare (1)	very rare	not evaluated
wood, (bark), *Picea*	1260-1580	rather rare (9)	rather frequent	
wood, (bark), *Picea*, conifers; (wood, *Fagus sylvatica* L.)	1350-1680	rather frequent (24)	Prealps: rather frequent	
bark, (wood), *Picea*; (bark, *Acer* L.)	1375-1655	very frequent (69)	frequent	
bark, *Picea*, (*Acer*)	1100-1550	infrequent (18)	rather frequent	
wood, *Picea*, *Pinus*	1300-1390	very rare (2)	rare	
bark, *Picea*, (*Acer*); (wood, *Picea, Pinus*)	1270-1680	very frequent (82)	frequent	
bark, *Picea*; (wood, *Picea*, *Pinus*)	1340-1600	frequent (40)	frequent	
bark, (wood), *Picea*; (bark, *Fagus* L.)	1100-1650	rather frequent (29)	frequent	
bark, *Fagus*	1120	very rare (1)	rather rare	
bark, *Acer*	1345-1390	very rare (2)	very rare	**EN**
bark, *Acer*	1330-1390	very rare (2)	very rare	**EN**
bark, *Picea*, (*Abies* Mill.)	1410-1645	infrequent (17)	rather rare	**VU**
bark, *Picea*	1470	very rare (1)	very rare	not evaluated
bark, *Picea*	1375-1650	frequent (44)	frequent	
bark, *Picea*	1270-1645	rather frequent (34)	rather rare	**VU**
bark, (wood), *Picea*; (bark, *Abies*, *Acer*)	1270-1680	very frequent (76)	frequent	
wood, *Picea*, *Pinus*, (*Fagus*); (bark, *Picea*)	1270-1620	rather rare (12)	rather rare	not evaluated
bark, *Picea*; (wood, *Pinus*)	1270-1545	rather rare (11)	rather rare	
wood, *Picea*, *Fagus*	1340-1430	rare (5)	rare	
bark, *Picea*	1440-1520	rare (7)	rare	
bark, *Acer*; (*Fraxinus excelsior* L.)	1250-1390 (710)	rare (3)	rare	
bark, *Picea*; wood, *Picea*, *Pinus*	1340-1650	rare (4)	rather rare	
resin, *Abies*	1360	very rare (1)	no other records	
stumps, (bark), *Picea*	1350-1520	very rare (2)	rare	
wood, (bark), *Picea*	1390-1680	rather rare (9)	rather rare	
wood, *Picea*, (*Fagus*)	1380-1580	rare (6)	rare	
wood, *Picea*, (bark, *Picea*, *Acer*)	1390-1645	infrequent (18)	rather rare	
bark, *Picea*	1445-1490	rare (3)	no other records	
bark, *Abies*	1275	very rare (1)	no other records	
bark, *Picea*	1350-1650	rather frequent (28)	rather frequent	
bark, *Picea*, *Abies*; wood, *Picea*, *Pinus*	1310-1450	rare (6)	rare	
bark, (wood), *Picea*	1445-1555	rare (4)	rare	
bark, (wood), *Picea;* (bark, *Abies*)	1275-1645	rather frequent (27)	rather rare	**VU**
bark, *Picea*	1530	very rare (1)	very rare	**EN**
wood, *Picea*	1540-1850	rare (3)	rather frequent	not evaluated
bark, *Picea*, (*Abies*)	1270-1650	frequent (50)	rather frequent	
wood, *Picea*, (*Pinus*, *Abies*, *Fagus*); (bark, *Picea*)	1200-1620	rather frequent (37)	rather frequent	
bark, *Alnus viridis* (Chaix) DC.	1560-1660	very rare (2)	rather rare	
bark, *Picea*	1450	very rare (2)	rather rare	**VU** *protected*
bark, *Abies*	1370	very rare (1)	very rare	**CR** *protected*
bark, *Picea*	1500-1580	rare (7)	rather rare	
bark, *Picea*, (*Abies*)	1375-1600	rare (4)	rare	
wood, *Picea*	1465	very rare (1)	rare?	not evaluated

Fig. 4. – *Calicium denigratum* (Vain.) Tibell, most ascomata pressed flat (*Schaerer s.n.* (G [G00057263]). Scale = 1 mm.

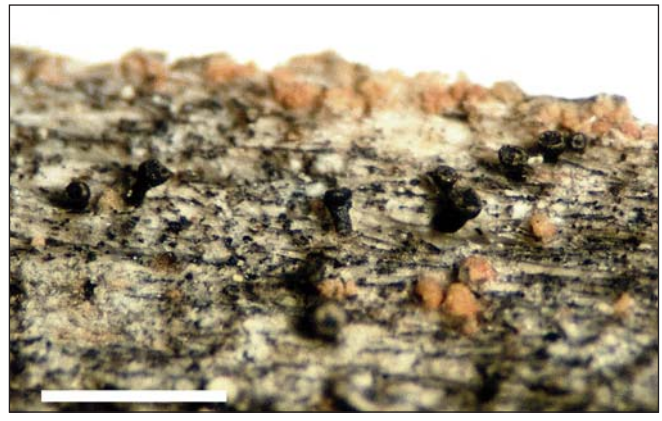

Fig. 5. – *Calicium pinastri* Tibell and pinkish discoloured areoles of *Hypocenomyce sorophora* (Vain.) P. James & Poelt (*Groner 610,* herb. Groner; old specimen). Scale = 1 mm.

5. *Calicium glaucellum*

Short-stalked herbarium specimens of *"Calicium glaucellum"* with a distinct thallus, dated before 1999, should be checked; these probably belong to *C. montanum.* The similar *C. parvum* Tibell, currently not recorded in the region, has clavate asci and diffractaic acid as the main lichen substance. *C. glaucellum* contains sekikaic acid.

6. *Calicium lenticulare*

At present, all observations of *C. lenticulare* in Switzerland have been on bark; additional records on wood are to be expected. Stalk and exciple I+ dark blue.

7. *Calicium montanum*

A recently described species (Tibell, 1999b), it grows on bark of old and/or dead branches of *Picea* and other conifers, and on wood. Pruina sometimes difficult to see. Thallus loosely granular to compact-warted, with divaricatic acid, and therefore easily separated from *C. glaucellum* with short stalks (see remarks under *C. glaucellum).*

8. *Calicium pinastri*

The specimen collected on July 19, 1988, with short, non-pruinose ascomata and obconical capitula (Fig. 5), had provisionally been determined as *C. glaucellum.* Asci cylindrical; spores 9-13.5 × 5-6.5 µm, ornamented with flat warts and shallow cracks. *Calicium pinastri,* published together with *C. montanum* (Tibell, 1999b), has recently been reported from Toregg (canton of Lucerne; Dietrich & Bürgi-Meyer, 2008b). Confusion possible with short-stalked *C. abietinum*, which has somewhat larger spores with a minutely warted surface. *C. parvum* usually has a whitish pruina (see *C. glaucellum).*

9. *Calicium salicinum*

Widely distributed on wood of conifers (e.g. Tibell, 1999a; Wirth, 1995), but in Switzerland almost exclusively corticolous (see remark under *C. abietinum).* Thallus immersed or thin, K+ yellowish. Lower side of capitulum not always brown, but more or less black.

10. *Calicium trabinellum*

Swiss records of this lichen are mostly corticolous, just like *C. abietinum* and *C. salicinum.* Thallus immersed; yellow pruina on lower side of the head.

11. *Calicium viride*

Widespread in Switzerland, lacking only in the lowest parts of the country. Thallus very rarely immersed; a single collection with unusually yellow to brown stalks.

12. *Chaenotheca brachypoda*

A species mainly on the bases of conifers and deciduous trees. Additional localities for this lichen are to be expected in the Prealps and Alps.

13. *Chaenotheca brunneola*

Chaenotheca brunneola is usually lignicolous, but all Swiss records to date are from bark (Stofer & al., 2008). Distinguished from more or less similar species by the absence of pruina, the immersed thallus, and the photobiont, which is trebouxioid *(Dictyochloropsis).*

14. *Chaenotheca chrysocephala*

Several specimens observed with the parasitic/parasymbiotic *Chaenothecopsis consociata* (Fig. 6).

15. *Chaenotheca ferruginea*

Predominantly in rather dry situations on acid bark and wood. Thallus K–, yellowish pigmented or rust-coloured parts K+ dark red.

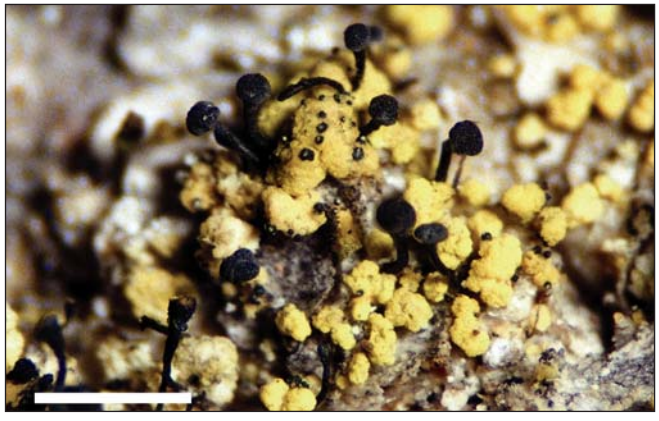

Fig. 6. – *Chaenothecopsis consociata* (Nádv.) A. F. W. Schmidt and pycnidia of *Microcalicium disseminatum* (Ach.) Vain. on *Chaenotheca chrysocephala* (Ach.) Th. Fr. (*Groner 1612,* herb. Groner). Scale = 1 mm.

16. *Chaenotheca furfuracea*

A corticolous and terricolous lichen species, found almost exclusively in rain-protected, shaded habitats.

17. *Chaenotheca gracilenta*

Ascomata partly parasitized by *Chaenothecopsis* cf. *savonica* (Räsänen) Tibell (Fig. 13). Ecological requirements about the same as *Chaenotheca furfuracea.*

18. *Chaenotheca hispidula*

One of the two known locations in the study area was destroyed in November 2007 (see Discussion). Thallus immersed, photobiont *Trentepohlia.*

19. *Chaenotheca laevigata*

Another *Acer* with this lichen was discovered after the loss of the first tree (see remark under *C. hispidula,* and Discussion). *Chaenotheca laevigata* has unmistakable spores and its thallus is warted-areolate, like that of *C. trichialis.*

20. *Chaenotheca phaeocephala*

In a variety of rather well-lit situations; apparently less sensitive than most other calicioid lichens regarding humidity.

21. *Chaenotheca sphaerocephala* (Fig. 7)

Reported as new to Switzerland by Dietrich & al. (2008) from Krienser Hochwald (canton of Lucerne); that collection was also on a single tree. Easily confused in its habitat on tree bases and in root cavities with *C. stemonea*. The photobiont, a trebouxioid alga, is distinguishable only under a microscope (compare *C. stemonea).* The similar *C. hygrophila* Tibell is characterized by singly-produced asci (non-catenulate) and a well-developed excipulum, in contrast to both *C. sphaerocephala* and *C. stemonea.* The lichen products of these three species, however, are more or less identical (Tibell, 1999a).

Fig. 7. – *Chaenotheca sphaerocephala* Nádv. (*Groner 2845,* herb. Groner). Scale = 1 mm.

22. *Chaenotheca stemonea*

Always on the lower part of the trunk and on the base. Thallus with *Stichococcus*. Confusion possible with *Chaenotheca sphaerocephala* (see that taxon).

23. *Chaenotheca subroscida*

Easily distinguished from other species with yellow pruina by the whitish granular to coralloid thallus.

24. *Chaenotheca trichialis*

On wood, the thallus is scarcely developed or immersed, much like *C. xyloxena.* In contrast to that species, the hyphae of the exciple of *C. trichialis* are parallel to the stalk surface (periclinally arranged; Fig. 8). Several times seen with the host-specific parasite/parasymbiont *Chaenothecopsis epithallina.*

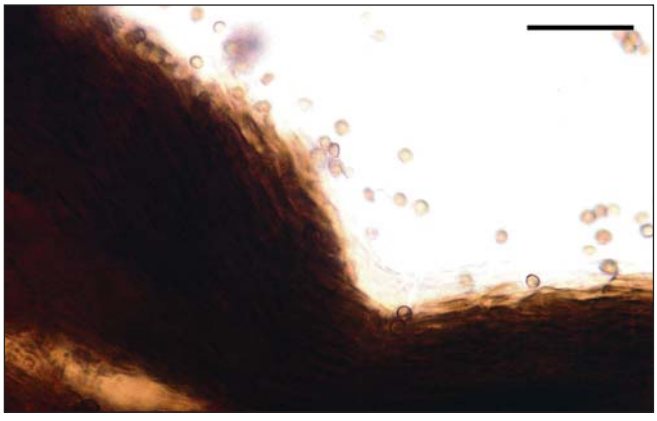

Fig. 8. – Exciple of *Chaenotheca trichialis* (Ach.) Th. Fr. with periclinal hyphae. Squash preparation with KOH. Scale = 30 µm.

25. *Chaenotheca xyloxena*

Thallus immersed. Outer hyphae of the exciple more or less perpendicular to the stalk surface (anticlinally arranged; Fig. 9). In the Bödmeren Forest area found a few times with *Chaenothecopsis pusiola* as a parasite/parasymbiont (Fig. 10).

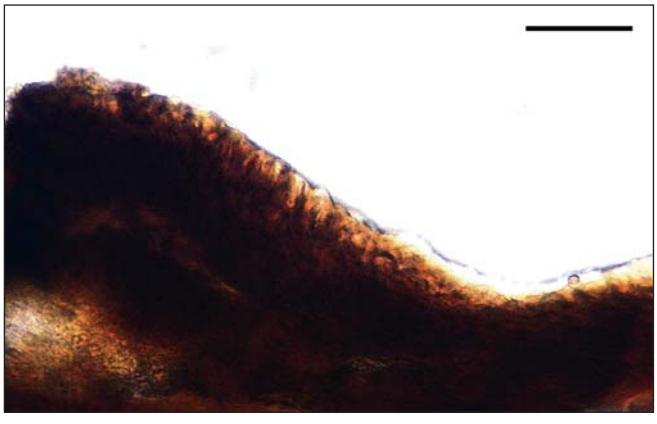

Fig. 9. – Exciple of *Chaenotheca xyloxena* Nádv. with ± anticlinal outer hyphae. Squash preparation with KOH. Scale = 30 µm.

Fig. 10. – *Chaenothecopsis pusiola* (Ach.) Vain. on *Chaenotheca xyloxena* Nádv. (*Groner 2848,* herb. Groner). Scale = 1 mm.

26. *Chaenothecopsis consociata*

Capitula occasionally somewhat pruinose (Fig. 6), these forms can be confused with *C. tasmanica.* However, *C. consociata* with a K+ red turning greenish reaction.

27. *Chaenothecopsis debilis* (Fig. 11)

Only two other Swiss collections, both dated before 1900 (cantons of Basel-Stadt, Basel-Land). In Groner (2006) presumably the first published records from Switzerland. Characteristic reactions of the pigments with K and N (sometimes weak or ephemeral).

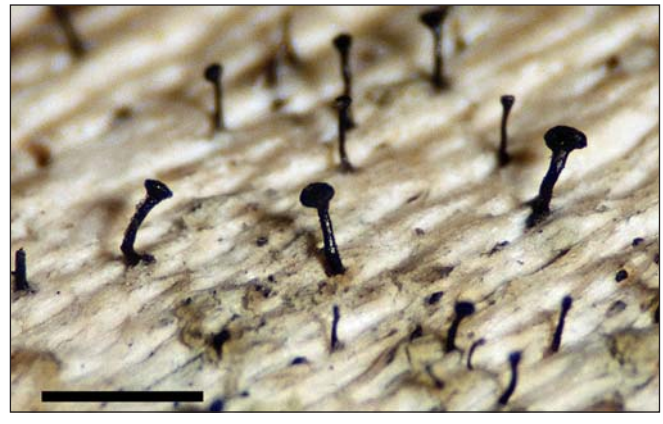

Fig. 11. – *Chaenothecopsis debilis* (Sm.) Tibell (*Groner 2942,* herb. Groner). Scale = 1 mm.

28. *Chaenothecopsis epithallina*

Ascomata K– (in contrast to *C. pusiola).* The affected areoles of *Chaenotheca trichialis* are often discoloured and disintegrating.

29. *Chaenothecopsis hospitans* (Fig. 12)

One collection outside of the study area, at 710 m; on *Fraxinus* L. *Chaenothecopsis hospitans* grows on saxicolous *Haematomma ochroleucum* (Neck.) J. R. Laundon as well; however, only four corticolous collections are known in the country. The first mentioned Swiss records probably in Groner (2006). Ascomata sessile or very short-stalked; yellowish or reddish pigments K+ distinctly red.

30. *Chaenothecopsis nana*

Ascomata K–. *C. nana* has spores similar to those of *Mycocalicium subtile,* but distinctly shorter asci than that species; compare also *Chaenothecopsis savonica.*

Fig. 12. – *Chaenothecopsis hospitans* (Th. Fr.) Tibell on *Lecanora albella* (Pers.) Ach. (*Groner 486,* herb. Groner; old specimen). Scale = 1 mm.

Fig. 13. – *Chaenothecopsis* cf. *savonica* (Räsänen) Tibell, young ascomata and pycnidia, on *Chaenotheca gracilenta* (Ach.) Mattsson & Middelb. (*Groner 2587,* herb. Groner). Scale = 1 mm.

31. *Chaenothecopsis oregana*

A single collection on resin and resin-soaked bark of a fir tree in the upper montane zone (coll. November 12, 2003). Recalls *C. rubescens* Vain. because of the non-septate spores and the K+ purplish reaction of the exciple. However, the substratum and ecology do not match with any known European species. The analysis of its DNA has shown that this specimen belongs to *C. oregana* (J. Rikkinen, *pers. comm.);* the species has been described rather recently (Rikkinen, 2003). This is the first record of a resinicolous *Chaenothecopsis* taxon in Switzerland.

32. *Chaenothecopsis parasitaster*

Observed several times in the Bödmeren Forest area by C. Scheidegger *(pers. comm.). Chaenothecopsis parasitaster* is very similar to *C. pusilla* and has by some authors been included as a synonym (e.g. Tibell, 1999a; Groner, 2006). However, recent molecular results indicate that *C. parasitaster* is a distinct species (L. Tibell, *pers. comm.).*

33. *Chaenothecopsis pusilla*

Rather variable with regards to size, colour and pruina. This probably represents a complex of unresolved species (Tibell, 1999a).

34. *Chaenothecopsis pusiola* (Fig. 10)

All specimens with greenish pigments (not yellowish to reddish as in Tibell, 1999a), reacting K+ dark red.

35. *Chaenothecopsis savonica*

Probably juvenile (without spores) on *Chaenotheca trichialis* and *C. gracilenta* (Fig. 13); possibly also saprobic on bark. Asci short, just like *Chaenothecopsis nana,* but the spores not fusiform. Greenish pigments K+ yellowish brown.

36. *Chaenothecopsis tasmanica*

Two other collections since Groner (2006); the only known locality in the country at present. Also on crustose lichens and non-lichenized algal colonies (Tibell, 1998; Selva & Tibell, 1999). Capitula bluish grey or bluish pruinose (Fig. 14); ascomata K+ yellowish to brownish. May be confused in the field with pruinose *C. consociata.*

Fig. 14. – *Chaenothecopsis tasmanica* Tibell, capitula subdivided, on *Chaenotheca chrysocephala* (Ach.) Th. Fr. (*Groner 2843,* herb. Groner). Scale = 1 mm.

37. *Chaenothecopsis vainioana*

Specimen with a few small ascomata; stalks pale brownish, not black or brownish black (Fig. 15). Grows as a parasite or parasymbiont on *Trentepohlia,* lichens containing *Trentepohlia* and apparently also with *Trebouxia* (Titov, 2006). Currently no other Swiss records.

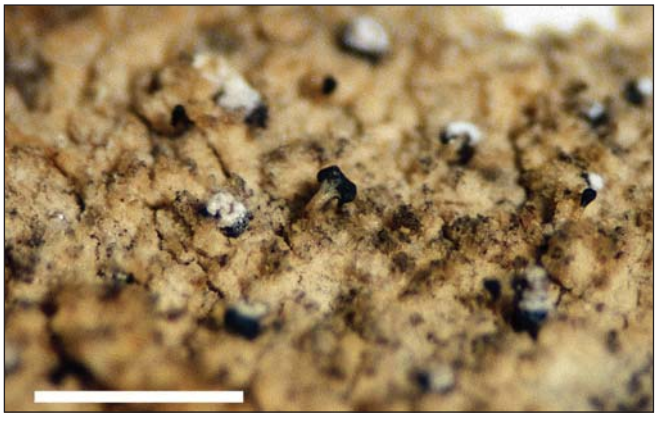

Fig. 15. – *Chaenothecopsis vainioana* (Nádv.) Tibell, stalk pale brown, on *Lecanactis abietina* (Ach.) Körb. with white pruinose pycnidia (*Groner 810,* herb. Groner; old specimen). Scale = 1 mm.

38. *Chaenothecopsis viridialba*

Probably also parasitic or parasymbiotic on *Chaenotheca chrysocephala.* Ascomata without the reddish pigments (i.e. with pale stalks) give a K± yellowish brown, not green, reaction.

39. *Chaenothecopsis viridireagens* (Fig. 16)

In the study area on *Chaenotheca xyloxena* and *C. stemonea,* among others. The stalks just below the head are often distinctly reddish brown.

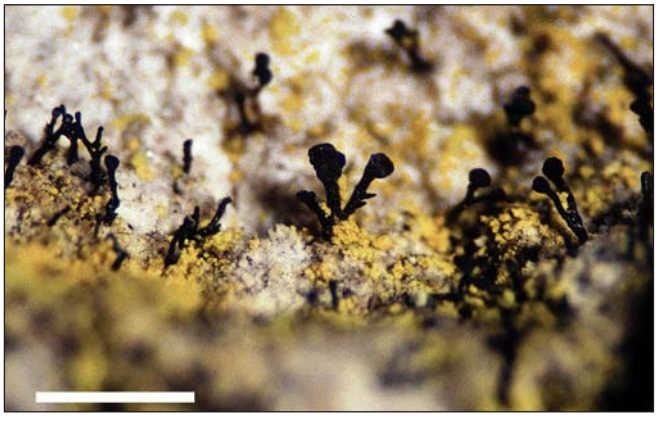

Fig. 16. – *Chaenothecopsis viridireagens* (Nádv.) A. F. W. Schmidt with branched ascomata, on indet. crustose lichen; with *Chrysothrix candelaris* (L.) J. R. Laundon (*Groner 2943,* herb. Groner). Scale = 1 mm.

40. *Cyphelium inquinans*

On one occasion together with *C. karelicum*. Thallus K+ yellowish (to reddish brown), very similar to *C. karelicum!* The (juvenile) spores possess a distinct ornament of more or less longitudinally arranged ridges and irregular cracks (Fig. 17).

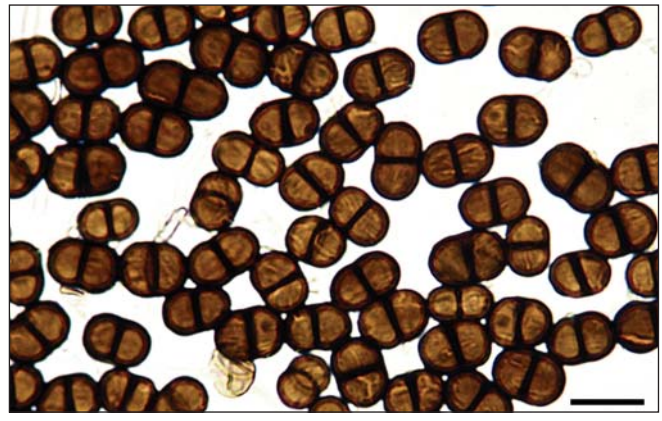

Fig. 17. – Ascospores of *Cyphelium inquinans* (Sm.) Trevis.; ornament of mostly longitudinally arranged ridges and irregular cracks. Scale = 15 µm.

41. *Cyphelium karelicum*

Alpine distribution like *C. inquinans,* but more frequent. Thallus K± yellowish, not Ch– as mentioned in Wirth (1995) and Tibell (1999a). According to these authors, *C. karelicum* has smaller apothecia than *C. inquinans.* However, the two species are not distinguishable without microscopical examination; young spores of *C. karelicum* are smooth, while mature spores bear deep cracks; their ornamentation is thus coarsely areolate (Fig. 18).

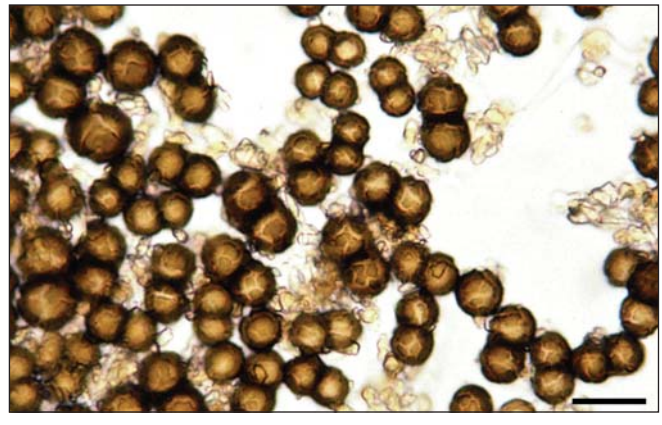

Fig. 18. – Ascospores of *Cyphelium karelicum* (Vain.) Räsänen; constricted at septum, ornament cracked areolate. Scale = 15 µm.

42. *Cyphelium lucidum*

Easily recognized by the yellow thallus and the distinct yellow pruina on the margin of the apothecia.

43. *Cyphelium tigillare*

On the wood of dead branches of *Picea.* In the dryer parts of the Alps most probably widely distributed.

44. *Microcalicium disseminatum*

Ascomata rarely with distinct short stalks. Found on *Chaenotheca chrysocephala* several times with conspicuous pycnidia (Fig. 6).

45. *Mycocalicium subtile*

Size, form and colour of the ascomata are all rather variable (Fig. 19). Easily confused in the field with species of *Chaenothecopsis,* but distinguished microscopically by its non-septate, broadly fusiform spores and long asci (always >30 µm).

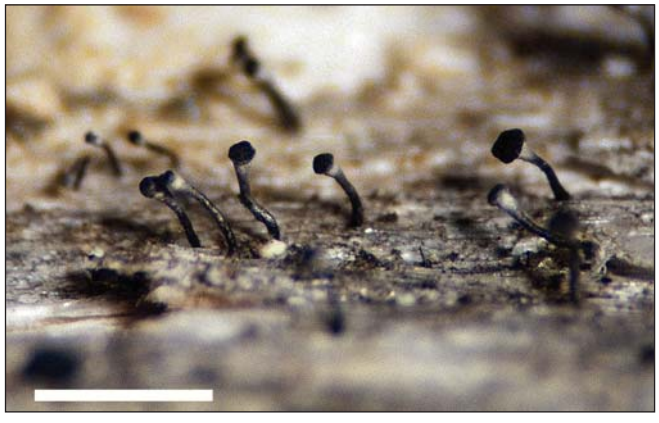

Fig. 19. – *Mycocalicium subtile* (Pers.) Szatala, exciple pale, greyish (*Groner 2863,* herb. Groner). Scale = 1 mm.

46. *Phaeocalicium compressulum*

Probably everywhere in stands of *Alnus* in the area. Spores dark brown; excipular hyphae periclinally arranged. The outer layer of the exciple of the similar *P. betulinum* (Nyl.) Tibell consists of isodiametric to irregular cells; in addition, the spores are pale brown (Tibell, 1999a).

47. *Sphaerophorus globosus*

Sphaerophorus is the only calicioid genus in the Bödmeren Forest region with shrubby thallus. A protected species (Natur- und Heimatschutz-Verordnung; NHV). Medulla I+ dark blue.

48. *Sphaerophorus melanocarpus*

Several sterile thalli found on a single tree. A remarkable oceanic element of the lichen flora, currently known only from Gurnigel (canton of Berne) and from Alpthal (canton of Schwyz). Protected species (NHV). Medulla I–.

49. *Sphinctrina anglica*

Four out of seven observations were on *Protoparmelia hypotremella* van Herk, Spier & V. Wirth. The host species of the other Swiss records are, unfortunately, not mentioned in Stofer & al. (2008).

50. *Stenocybe major*

This fungus usually prefers old *Abies* (Wirth, 1995; Titov, 2006); in Switzerland possibly much overlooked.

51. *Thelomma ocellatum*

A single collection from a wooden fence post; the lichen was mostly sterile with only a few scattered apothecia. Resembles sterile morphs of *Trapeliopsis flexuosa* (Fr.) Coppins & P. James. Therefore, several old reports and specimens should be verified. Medulla I+ dark blue.

Discussion

Calicium denigratum

According to Clerc (2004), neither observations nor collections of *C. denigratum* have ever been published in Switzerland. However, there are certainly specimens of this taxon deposited in various herbaria, with outdated nomenclature or named using old systematic concepts. I have examined one of L. E. Schaerer's specimens from the upper Emmental, canton of Berne (Fig. 4), which is actually *C. denigratum (Schaerer s.n.* (G [G00057263]). The label reads: "Calicium nigrum v. pusillum Schaer. Ad truncos putridos in valle Buembach. Jul. 1825" (the year not clearly legible). As stated by Tibell (1999a), the species occurs in Scandinavia, in continental Europe, and in Siberia. Both the habitat and substrate of *C. denigratum* in the Bödmeren Forest agree well with the description in Tibell (1999a). On the other hand, the usual companion species *Chaenothecopsis fennica* (Laurila) Tibell mentioned for Scandinavia has not yet been recorded in Switzerland.

Species diversity

The Bödmeren Forest area in the Muota Valley has by far the most diverse flora of calicioid lichens and fungi in Switzerland, with 51 lichenized and non-lichenized species currently listed (Table 1). However, the calicioids in other Swiss regions are, with few exceptions, poorly known at best (see comparison in Camenzind-Wildi & al., 1996). About 68 calicioid taxa are known today in the country – of which a considerable 75% are present in the Bödmeren Forest region. Likewise, the species diversity of the investigated area of only 14 km^2 is remarkably high, compared with the numbers of calicioid taxa of neighbouring countries, although not all counts are up to

date. WIRTH (1995), several years ago, listed ca. 58 calicioid lichens and fungi for the German Land Baden-Württemberg, HAFELLNER & TÜRK (2001) mentioned 54 species for Austria, and NIMIS & MARTELLOS (2008) noted 65 taxa for Italy. No comparably rich calicioid flora is known today from a similarly small area in these countries; the study area is probably exceptional in central Europe.

The first published records in Switzerland of *Calicium adaequatum* (GRONER, 1994), of *Chaenothecopsis tasmanica* and *C. vainioana* were from the Bödmeren Forest region (GRONER, 2006). The same presumably applies to *C. debilis, C. hospitans* and *C. pusiola*, also listed in the cited work. *Calicium denigratum* and *Chaenothecopsis oregana,* as described above, are additional calicioid taxa new to the country; moreover, this is probably the first report of *C. oregana* in central Europe. Other remarkable species found as part of this survey include the recently reported *Calicium pinastri* (DIETRICH & BÜRGI-MEYER, 2008b) and *Chaenotheca sphaerocephala* (DIETRICH & al., 2008), the latter recorded here for the second time in the country. The study area hosts 14 of the 16 currently known species of *Chaenotheca* in Switzerland, as well as 11 of the 14 *Calicium*-species, and 14 of the 18 *Chaenothecopsis*-taxa. These numbers definitively confirm the species-richness of the area, as stated previously in an inventory of the epiphytic macro-lichens (GRONER, 1990). The diversity of the calicioid flora is, just like that of the macro-lichens, favoured by several ecological factors combined in the Bödmeren Forest area: Stands with elevated air humidity as a result of high precipitation; numerous suitable micro-habitats on bark and wood; many highly inaccessible spots without any logging; carefully managed stands without documented large clear-cuttings in the past; stands of trees demonstrating long ecological continuity, with many old trees and substantial quantities of dead wood (primeval forest relics; STIFTUNG URWALDRESERVAT BÖDMEREN, 2005). The Bödmeren Forest area almost perfectly matches the ecological requirements of the majority of the calicioid taxa.

Frequencies, Substrata, Distribution

The most frequent species in the Bödmeren Forest s.str., as well as in the rest of the study area, are *Chaenotheca chrysocephala*, *Calicium viride* and *Chaenotheca trichialis* (Table 1). *C. chrysocephala* was noted on two thirds of the 300 spruce trees studied by GRONER & FREI (2005), whereas the two other taxa were present on somewhat more than half of the trees. *Microcalicium disseminatum* was found on 28% of the trees; all other calicioid lichens and fungi were less frequent or rare. As expected, the number of species on bark and wood of conifers is high, while the number on deciduous trees is rather low. However, some rare calicioids such as *Chaenotheca gracilenta*, *C. hispidula* and *C. laevigata,* and the substrate-specific *Calicium adaequatum* and *Phaeocalicium compressulum* occur only on deciduous trees or shrubs. An important substrate is dead wood: 40% of all species (parasites included) grow on wood and on bark, eight taxa are exclusively lignicolous. In general, the number on stumps is low, and the records on logs are very rare. The presence of snags (standing dead trees) is therefore of crucial importance for diversity and frequency of the calicioid taxa. Calicioid species on rocks or on saxicolous lichens have until now not been recorded in the study area.

The calicioid lichens and fungi in the Bödmeren Forest region are not evenly distributed, but clearly delimited areas with concentrations of calicioid species ("hot spots") apparently do not exist, as demonstrated in the central part of the study area (Fig. 20, 10 relevés are added in the southern part compared to Fig. 3.7-2 of GRONER & FREI, 2005). The recorded localities of a taxon are either more or less dispersed or, in several cases, too scanty for an interpretation. Most species occur between ca. 1250 and 1650 m throughout the forested parts, obviously more frequent and with higher species numbers in stands offering suitable habitats and appropriate climatic conditions.

Indicator species

The occurrence and the absence of epiphytic lichens, namely of rare species and/or species with higher ecological requirements, allow conclusions to be drawn about the state and evolution of a particular forest. The method of using selected taxa as indicator species, and the calculation of indices to assess the ecological continuity of forests, goes back to the work of ROSE (1976). In an investigation by TIBELL (1992), several crustose lichens and calicioid species proved suitable as indicator organisms for old-growth forests, i.e. as indicator species for forests with long continuity. SELVA (2002) suggests the use of calicioid taxa alone for this purpose.

An investigation with this approach in the Bödmeren Forest s.str. was only partly successful (GRONER & FREI, 2005); therefore, several relevés have been added later. On this basis, the distributional and frequency data roughly match the other evaluated characteristics of old-growth forest (LIECHTI & BURGER, 2005). The test sites with the highest numbers of calicioid lichens and fungi were recorded in the forest parts 5 and 6 (Fig. 20), which contain not only the oldest trees of the investigated area (400-500 years), but in addition showed high tree age averages on several plots (250-300 years; HORAT & al., 2005). Most of parts 5 and 6, together with part 2 (the forest reserve), are regarded as primeval or close to primeval forest by LIECHTI & BURGER (2005). The low species numbers on some plots here are mainly due to unfavourable climatic conditions (GRONER & FREI, 2005). A few rather species-rich test sites were found in areas 1 and 4 (Fig. 20), where logging was common during the last 100 years (LIECHTI & ROTH, 2005; LIECHTI & BURGER, 2005). Apart from calicioid

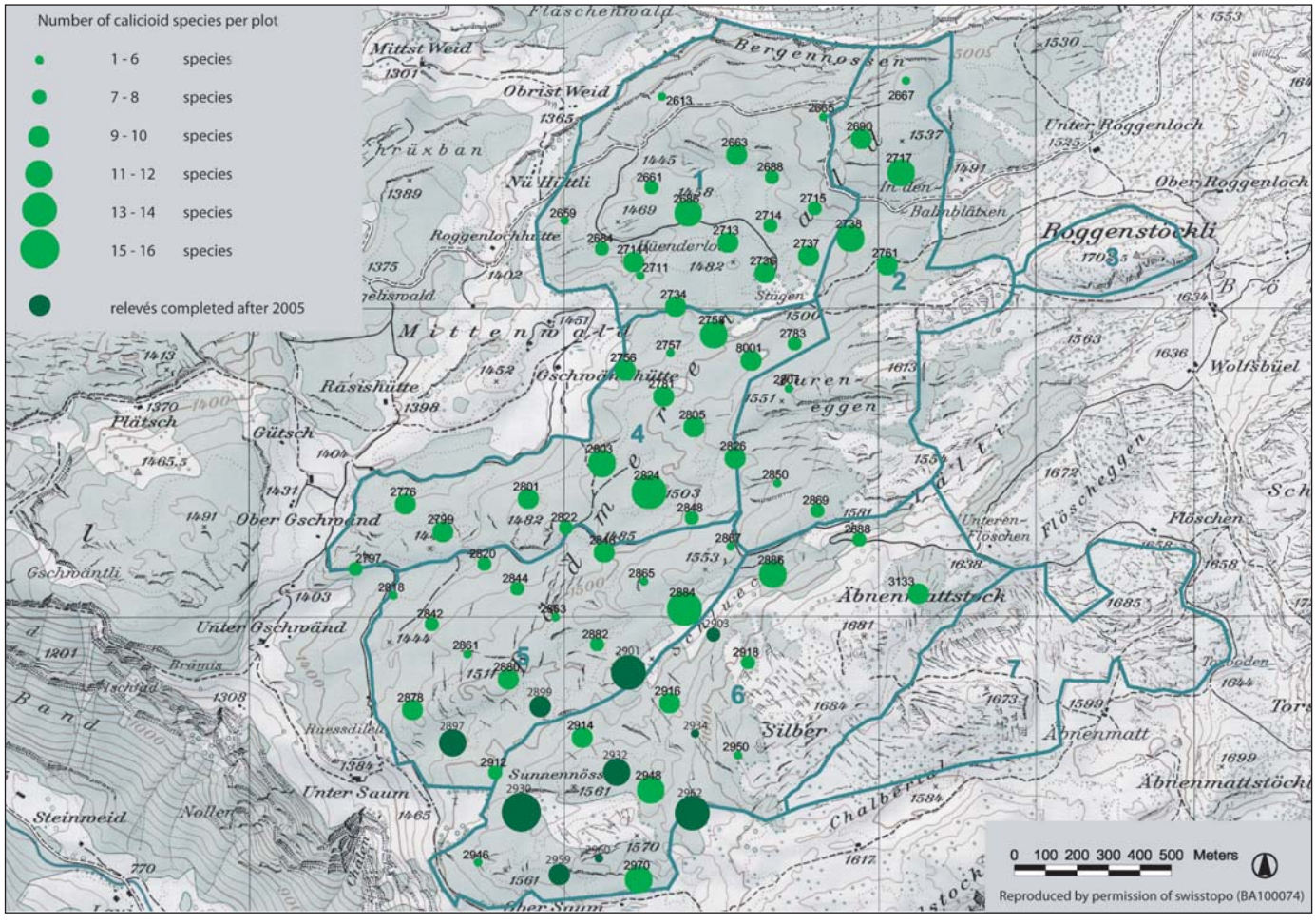

Fig. 20. – Frequencies of the calicioid species recorded in the Bödmeren Forest s.str. [Forest area limits in blue; size of the dots is arbitrary].

taxa, other old-growth forest indicator species were recorded as well (e.g. *Usnea longissima* Ach.; GRONER & FREI, 2005). Obviously, the availability of suitable ecological niches, as observed also in these harvested parts of the forest, is very important. The calicioid lichens und fungi, and epiphytic lichens in general, of the Bödmeren Forest can be used as indicators of long ecological continuity only when combined with other indicators, such as tree age, occurrence and quantity of dead wood, etc. The study area with old trees and calicioid species in abundance apparently is not a perfect example for the potential of the calicioid taxa as indicators, but the results set a good standard for future studies in prealpine forests.

Threatened taxa

One third of the 32 calicioid lichen species present in the Bödmeren Forest region appear to be threatened (Table 1): 6 species are classified in "Red List" category VU, 4 in EN, and one in CR (SCHEIDEGGER & al., 2002). Unfortunately, not all recorded species are considered in the "Red List", the state of the recently discovered and of the lignicolous taxa is not determinable. The percentage of endangered and vulnerable species is therefore presumably higher. A low estimate indicates that at least 42% of the calicioid lichens – currently 11 out of 26 classified taxa – are threatened; 19% are endangered or critically endangered. A "Red List" for the non-lichenized calicioid fungi does not exist, so the 19 parasitic, parasymbiotic (or commensalistic) and saprobic species recorded in this study were not considered. Nothing much is known about the distribution and rarity of these taxa, with the exception of *Chaenothecopsis* (GRONER, 2006). The non-lichenized genera, traditionally studied by lichenologists, need to be included in an updated "Red List".

Experience has shown that rare species often occur on a single tree or in a confined, small area; the exception in the Bödmeren Forest is *Usnea longissima,* growing on quite many spruce trees (GRONER, 1990). On the other hand, examples for only once- or twice-recorded calicioid taxa are numerous: *Calicium denigratum, Chaenotheca brunneola, C. sphaerocephala,* etc.

The risk of extirpation of such isolated populations is very high, as demonstrated in the case of *C. hispidula-laevigata.* One of only two known host trees was cut in autumn 2007. The sycamore in question, which supported *C. hispidula, C. laevigata* and *Chaenothecopsis hospitans* among other calicioids, had obviously been removed for a temporarily installed cable used for the transport of logs. The protection and conservation of rare species are difficult under these economically controlled circumstances, especially in the case of small, often inconspicuous taxa. However, a conservation strategy must be broadly based, not on the rare calicioid species alone, because this region harbours not only rare and threatened epiphytic lichen taxa, but also several rare species on rotten wood, on soil and on rock with different ecological requirements.

Lichenological research in the Bödmeren Forest area will continue after this inventory of the calicioid lichens and fungi, there are probably additional species to be discovered also from this fascinating group. The study area is obviously valuable from a conservation perspective, with numerous and rare taxa – this remarkable species diversity (not only of the calicioids) must be preserved. However, the pressure on the Bödmeren Forest ecosystem has considerably increased during the last years due to increasing human activities, like tourism, recreation, sports etc. A certain natural protection though exists in the area: Leaving the road, or the trails, is not recommended in places with a rough, rocky terrain, with karst pits and crevices. The significant enlargement of the forest reserve, as agreed in 2009 by cantonal authorities and the land owner, is certainly an important measure towards protection and conservation of threatened species. An inventory like the present study should, of course, document existing species, rather than extirpated or extinct ones.

Acknowledgements

I am most grateful for help in this mainly privately financed lichen project: to Leif Tibell (Uppsala) for the revision of specimens and for valuable information; to Jouko Rikkinen and Hanna Tuovila (Helsinki) for the determination of the resinicolous specimen; to Alexander Titov (St. Petersburg) for his book about the Mycocalicioids; to Rosmarie Honegger (Zurich) for information and literature concerning lichen algae; to Bruno Suter (Muotathal) for support during fieldwork in the Bödmeren Forest; to Michael Dietrich (Kriens) for corrections and improvements of an earlier draft of the manuscript; to the members of Stiftungsrat Urwaldreservat Bödmeren for a contract within their primeval forest project; to Elizabeth Feldmeyer-Christe (Birmensdorf) for correcting my French summary; to Scott LaGreca (Pittsfield) for improvement of my English text.

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