Notes on selected terricolous crustaceous lichens of Switzerland: Distributional, ecological and Red List data

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The determination of specimens collected within the framework of the Swiss Lichen Red List project yields information concerning 20 species of terricolous crustaceous lichens: *Bacidia bagliettoana*, *Biatora subduplex*, *Bilimbia lobulata*, *B. microcarpa*, *B. sabuletorum*, *Buellia hypophana*, *B. papillata*, *B. punctata*, *Diplotomma geophilum*, *Helocarpon crassipes*, *"Lecidea" berengeriana*, *"Lecidea" hypnorum*, *"Lecidea" rufofusca*, *Lecidella wulfenii*, *Lopadium pezizoideum*, *Micarea lignaria*, *M. peliocarpa*, *Mycobilimbia carneoalbida*, *M. tetramera* and *Protomicarea limosa*. The ecology and Swiss distribution of each species are discussed, and the species are evaluated according to IUCN methodology. Categories of threat are assigned to twelve species previously classified as DD (data deficient). The relationship between the extreme climatic conditions endured by these species and their muscicolous habitat is discussed.

Zusammenfassung: BEAUCHAMP, H., VUST, M. & CLERC, P. 2007. Bemerkungen über ausgewählte, auf Erde wachsende Krustenflechten in der Schweiz: Informationen zur Verbreitung, Ökologie und Roten Liste. – Herzogia **20**: 115–144.

Es werden die Bestimmungsergebnisse vorgestellt, die im Zusammenhang mit dem Projekt einer Schweizer Roten Liste für Flechten gesammelt worden sind. Es betrifft 20 auf Erde wachsende Krustenflechten: *Bacidia bagliettoana*, *Biatora subduplex*, *Bilimbia lobulata*, *B. microcarpa*, *B. sabuletorum*, *Buellia hypophana*, *B. papillata*, *B. punctata*, *Diplotomma geophilum*, *Helocarpon crassipes*, *"Lecidea" berengeriana*, *"Lecidea" hypnorum*, *"Lecidea" rufofusca*, *Lecidella wulfenii*, *Lopadium pezizoideum*, *Micarea lignaria*, *M. peliocarpa*, *Mycobilimbia carneoalbida*, *M. tetramera* und *Protomicarea limosa*. Von jeder Art werden die Ökologie und die Verbreitung in der Schweiz besprochen, sowie die Arten nach der IUCN-Methode bewertet. Für zwölf, ursprünglich als DD (Daten unvollständig) eingeordnete Arten werden Gefährdungskategorien festgelegt. Die Verbindung zwischen den extremen Bedingungen, denen diese Arten ausgesetzt sind, und ihrem Wuchsort auf Moosen wird besprochen.

Key words: Lichenized Ascomycetes, biodiversity, Alps.

Introduction

Terricolous lichens are often found growing under conditions few other plants can survive. They colonize areas where, for reasons of drought, cold, lack of soil, or lack of nutrients, vascular plants do not grow well. They are also found in disturbed areas where they are often the first pioneer species to colonize the soil; yet they are soon crowded out and replaced by more competitive species, except in the least hospitable of conditions.

Despite growing awareness of the necessity of protecting endangered species from extinction, the terricolous lichen flora of Switzerland has been largely ignored. Until the recent work of VUST (2002) concerning the terricolous lichens of Switzerland, no exhaustive study had been undertaken to analyze this group. The result of his study is a global picture of the terricolous

lichens of Switzerland, including their ecologies, geographical distributions, and categories of threat. The aforementioned project was launched within the framework of the federal project to develop a Red List of epiphytic and terricolous lichen species (SCHEIDEGGER & CLERC 2002). However, because of time and funding restrictions, not all of the samples collected during the three-year field campaign could be identified in time for the publication of the Red List (CLERC & VUST 2002).

An identification of some of the remaining samples collected during the course of Vust's study will shed further light on the developing knowledge concerning terricolous lichens in Switzerland, as well as the ecological needs and the distribution of each species. The protection of lichen habitats depends on their identification; by better understanding the needs of an endangered species we can better act to preserve or create conditions favorable to its development. Furthermore, species that are now not threatened may become so if their ecological needs are ignored and their habitat destroyed. The rating system and classification according to the Red Lists are tools that allow policy-makers to prioritize habitat protection, and thus to most effectively distribute conservation efforts.

The present paper is intended as a complement to the aforementioned work (CLERC & VUST 2002). The results of the identifications are a species list, the Swiss distribution, an ecological profile, and a Red List rating for each species considered.

Materials and methods

The term "terricolous" is used here in a broad sense as discussed and defined by CLERC & VUST (2002) including species that grow on bare soil, on mosses on bare soil, on accumulated soil in rock fractures, or on plant debris on bare soil. Almost the same definition was used by NIMIS & MARTELLOS (2004).

The terricolous specimens considered in this study were chosen among Vust's remaining unidentified samples according to the following macroscopic morphological characteristics: crustaceous thallus, colours ranging from white to beige to brown, but no bright colours, and in general, dark apothecia.

Specimen collection took place throughout Switzerland between 1995 and 1999. Two types of sampling were considered. Relevé A sites were chosen using a hierarchical random sampling plan based on the 31 major types of vegetation recognized in Switzerland (HEGG et al. 1993). These vegetation types correspond to plant formations that are typical of a given altitude, latitude and climate. Ten sampling sites were generated randomly in each vegetation type. Each sampling site consisted of a 1 km^2 zone located using GPS coordinates. The goal of this sampling plan was to efficiently cover the area necessary in order to have a statistically equal chance of finding terricolous lichen species in all of the possible habitats (see CLERC & VUST [2002] for a detailed description of sampling methods).

The second sampling method consisted of choosing additional sampling sites. These sites (relevés B) were included in order to increase the chances of finding a maximum number of lichen species, and in order to expressly search for lichen-rich habitats so rare that they would not appear in the randomly generated sampling sites (e.g. bogs). The two different sampling methods are taken into account when classifying terricolous lichen species according to the categories of threat for the Red List.

The specimens were mainly identified according to NIMIS & MARTELLOS (2004), PURVIS et al. (1992), and WIRTH (1995). Some of the identifications required verification using standardized

thin-layer chromatography (TLC) following CULBERSON & AMMANN (1979) with the solvent B modified according to CULBERSON & JOHNSON (1982).

The nomenclature is based on SANTESSON et al. (2004) and CLERC (2004) with modifications concerning the taxa of the genus *Bilimbia* (VELDKAMP 2004), *Buellia punctata* (BUNGARTZ et al. 2004), "*Lecidea*" *berengeriana* and "*Lecidea*" *hypnorum* (EKMAN 1996). Sometimes the genus is quoted, meaning that the species belongs to another still undefined genus.

A total of 188 specimens were identified. The specimens were deposited in the herbarium of the Conservatoire et Jardin botaniques de la Ville de Genève (G). The localities listed (specimens studied) describe only the specimens identified here. The dots included on the distribution maps comprise these specimens as well as those identified in the course of Vust's thesis, an additional 40 specimens that bring the total number of specimens to 228.

For each species considered, we attributed a Red List category of threat according to the method employed in CLERC & VUST (2002, see Fig. 5 and Tables 6 and 7). This method relies on the following criteria used by the IUCN to establish the category of threat: presence or absence in the relevé A samples, number of occurrences in the relevé B samples, presence in a threatened habitat, percentage of specimens found growing in threatened habitats, and occasionally an expert decision (CLERC & VUST 2002). The categories of threat are abbreviated as follows: EX (extinct), RE (regionally extinct), CR (critically endangered), EN (endangered), VU (vulnerable), NT (near threatened), LC (least concern) and DD (data deficient).

When a species was found in the relevé A samples this implies that its presence in Switzerland is common enough to account for its appearance in statistically chosen sites. When this same species was found in relevé A samples growing in habitats considered threatened in Switzerland, this increases the category of threat ascribed to the species. As the percentage of occurrences in threatened habitats increases, the level of threat increases as well (CLERC & VUST 2002: Table 7). For species that were only found in the relevé B samples, a slightly different approach was taken. For all of the species already reported from Switzerland (as was the case with all of the species considered in this study), the number of localities found and the level of threat of the habitat where the species was growing were considered. For species with fewer than 3 localities, the assigned level of threat was NT for those species not found growing in threatened habitats, and CR for those found in threatened habitats. For species with 3 or more localities, the categories were LC and EN, respectively.

We compared the distribution obtained from the specimens studied with what is known from the literature (CLERC 2004). The distribution of each species was evaluated according to cantonal boundaries as well as the five major biogeographical regions of Switzerland (LANDOLT 1991, CLERC 2004) (Fig. 1).

Results

The distributional data of the species considered in this study are summarized in Table 1. The Red List data are summarized in Table 2.

Bacidia bagliettoana (A.Massal. & De Not.) Jatta

Identifications were confirmed by the distinctive long, acicular, poly-septate ascospores, the characteristic black brown to red brown excipulum (K+ purple) fading in the interior, and by the K+ red hypothecium. This species was distinguished from *Bilimbia sabuletorum* due to its thinner ascospores and

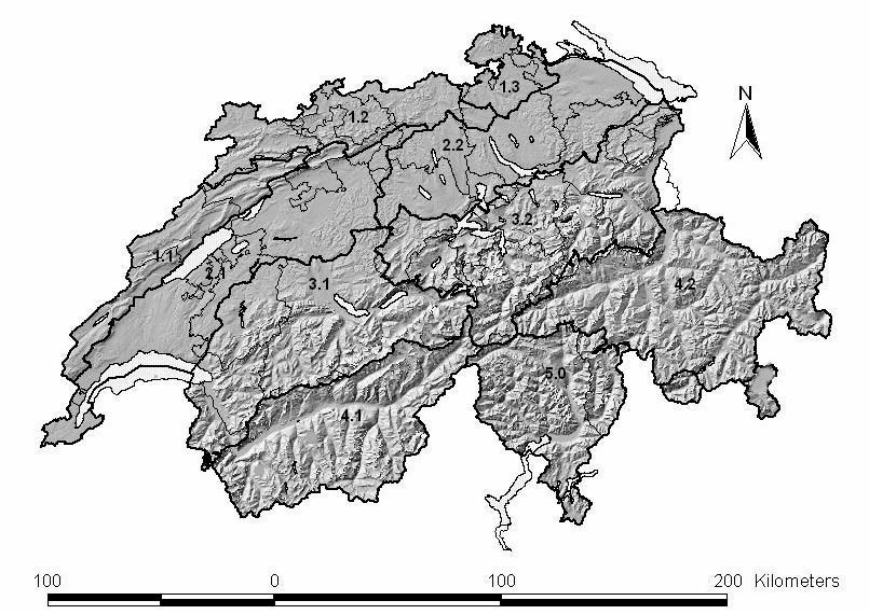

Fig. 1: The five Swiss biogeographical regions. 1.1: Western Jura Mountains, 1.2: Northern Jura Mountains, 1.3: Northwest Switzerland, 2.1: Western Plateau, 2.2: Eastern Plateau, 3.1: Western Northern Swiss Alps, 3.2: Eastern Northern Swiss Alps, 4.1: Western Central Swiss Alps, 4.2: Eastern Central Swiss Alps, 5: Southern Swiss Alps.

its more planar and less convex apothecia (Fig. 5a). One character that may be helpful for distinguishing the two species in the field is the greater variability of apothecium colour in *B. sabuletorum*.

In general, this is an arctic-alpine to boreal-montane, circumpolar lichen (NIMIS & MARTELLOS 2004). Within Switzerland it has been reported growing in all of the biogeographical regions except the Southern Alps, and at altitudes ranging from the colline to the alpine vegetation belt (CLERC 2004). The species is new for the cantons of Jura, and Neuchâtel (Fig. 2). However, there are many cantons in which the species had been found historically but failed to appear here: the cantons of Basel, Bern, Luzern, Uri and Zürich were lacking the species, as was the Eastern Plateau (CLERC 2004). In the course of later studies, this species was found in the canton of Geneva (BURGISSER et al. 2004, VUST 2006).

Typical habitat consists of "mosses or plant debris on calcareous rocks (including old rock walls) or on the ground in chalk or limestone grassland or calcareous dunes" (COPPINS 1992a). The specimens identified in the course of this study were found on a variety of structures ranging from bare soil to old walls in locations with calcareous rock formations, which is in keeping with its essentially calcicolous nature (WIRTH 1995). Many specimens were collected under dry conditions, such as in wind-exposed settings or in xerophilic forests. All were collected over bryophytes or plant debris, and occasionally directly on the adjacent bare soil.

Bacidia bagliettoana is considered threatened in Germany and the Netherlands (Table 2) and is considered vulnerable (VU) in Switzerland due to the fact that many of the habitats in which it was recorded are considered threatened, notably the Xerobromion, Quercion pubescenti-petraeae, and Ononido-Pinion (DELARZE et al. 1998).

Selected specimens studied: Graubünden: Feldis, rocaille calcaire dans une lande alpine ventée, 754.45/185.05, alt. 2000 m, sur bryophytes et débris de plantes, 5 juin 1999, Vust (G); Tarasp, rocaille dans une végétation des dalles calcaires et lapiez de montagne, 816.225/185.225, alt. 1430 m, sur bryophytes et débris de plantes, 12 juin 1998, Vust (G); **Jura**: Haute Roche, rocaille calcaire dans un pâturage, 593.1/238.45, alt. 1070 m, sur bryophytes et débris de plantes, 23 avril 1998, Vust (G); **Neuchâtel**: Couvet, Mont-Brenin, mur de pierres sèches dans pâturage,

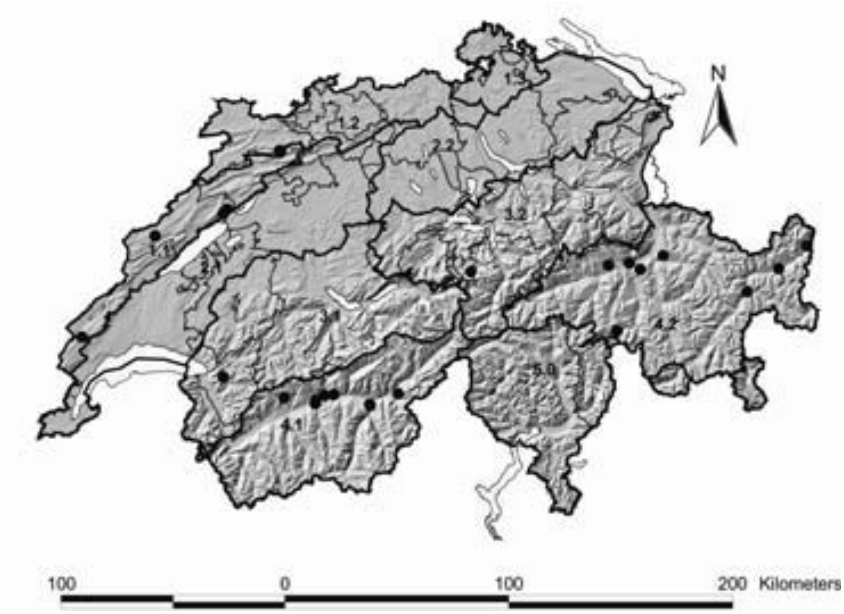

Fig. 2: Known Swiss distribution of *Bacidia bagliettoana.*

537.62/200.08, alt. 1115 m, sur bryophytes et débris de plantes, 23 octobre 1996, Vust (G); Cornaux, vieux murs dans des vignes, 568.1/210.025, alt. 455 m, sur bryophytes, 17 mars 1997, Vust (G); Cressier, Bellevue, rocaille calcaire dans une pelouse mi-sèche, 569.75/211.9, alt. 590 m, sur bryophytes, 10 avril 1996, Vust (G); **Obwald**: Fürenalp, grés calcaires dans une végétation des dalles siliceuses de montagne, 678.9/183.9, alt. 1840 m, sur débris de plantes et terre nue, 13 mai 1998, Vust (G); **Valais**: Riedalpji, pinède continentale xérophile, 646.226/129.526, alt. 1400 m, sur bryophytes et débris de plantes, 14 juillet 1998, Vust (G); Sierre, bois de Finges, rocaille calcaire dans une pinède continentale xérophile, 609.51/126.65. alt. 600 m, sur bryophytes et terre nue, 14 mai 1997, Vust (G); **Vaud**: Tour-de-Famelon, gazon des crêtes ventées, 568.075/136.95, alt. 2137 m, sur bryophytes, 9 août 1996, Vust (G); Chalet à Roch, graviers calcaires fins dans un pâturage, 504.75/155.05, alt. 1425 m, sur bryophytes, 15 juillet 1996, Vust (G).

Biatora subduplex (Nyl.) Printzen

The individuals of this species were noticeable due to their orangish-yellow apothecia (Fig. 5b), pale hymenium, and non-septate ascospores. Care was taken to distinguish this species from *B. vernalis* due to the latter's smaller ascospores and more marked apothecial pigmentation in section (PRINTZEN 1995).
This species is present throughout most of Europe and North America, and can be regarded as a (sub-) arctic-alpine species (PRINTZEN & PALICE 1999). Indeed, it is the "most common (sub-) alpine *Biatora* species with the broadest ecological amplitude" (PRINTZEN & PALICE 1999). In Switzerland this species has previously been reported growing at a large range of altitudes in all biogeographical regions except the Western Plateau (CLERC 2004). The Swiss distribution of the epiphytic specimens collected during the Lichen Red List project is given by STOFER et al. (2003).
Typical habitat includes plant debris, mosses, and tree bark in proximity to the ground (PRINTZEN & TØNSBERG 1999). Typical of many *Biatora* species, *B. subduplex* withstands low light conditions well but requires humid microclimates, and tends to be collected under conditions where "late snow cover provides shelter from drought" (PRINTZEN & PALICE 1999).
Biatora subduplex is often collected on the basal part of subalpine shrubs (NIMIS & MARTELLOS 2004). In his thesis, VUST (2002) included *B. subduplex* in the list of lichen species that are principally corticolous, but that were found on terricolous substrata, and hence the species was considered in the Epiphytic Lichen Red List. Five terricolous specimens were identified: two in Valais, one in Bern and

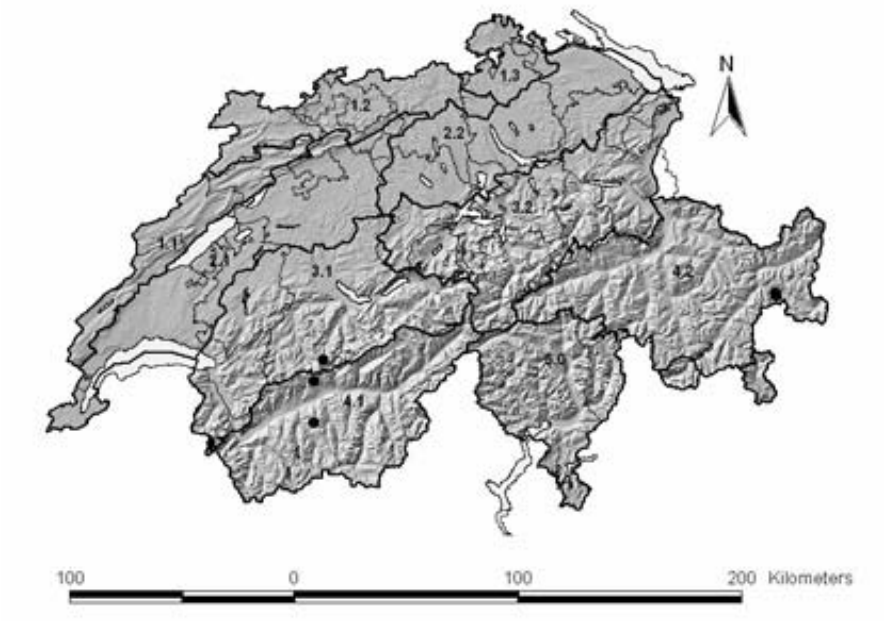

Fig. 3: Known Swiss terricolous distribution of *Biatora subduplex*.

two in Graubünden (Fig. 3). The abundance of acceptable epiphytic and terricolous habitats contributes to this species' success and to its being classified as LC.

Selected specimens studied: Bern: Engstligen-alp, fentes de rocher calcaire dans une pelouse calcaire, 608.8/141.975, alt. 2150 m, sur bryophytes et débris de plantes, 6 octobre 1998, Vust (G); **Graubünden**: Parc national, pinède subcontinentale basophile, 811/170.25, alt. 2050 m, sur bryophytes et débris de plantes, 17 juin 1997, Vust (G); **Valais**: Vallon de Réchy, combe à neige calcaire, 604.575/113.775, alt. 2600 m, sur bryophytes et débris de plantes, 15 août 1996, Vust (G).

Bilimbia lobulata (Sommerf.) Hafellner & Coppins (Syn.: *Myxobilimbia lobulata* [Sommerf.] Hafellner, *Toninia lobulata* [Sommerf.] Lynge)

This taxon is characterized by the unique, lobed appearance of the thallus squamules (Fig. 5c), the bluish-green epihymenium, and the non- to three-septate ascospores. These latter resemble those of *B. sabuletorum* but remain shorter at maturity, reaching a maximum length of approximately 26 µm (compared to 40 µm for *B. sabuletorum*). Determinations were occasionally verified using TLC revealing the presence of zeorin (TIMDAL & JAMES 1992).

This is a cool-temperate, arctic-alpine, circumpolar lichen common from the Alps to the high Mediterranean mountains (NIMIS & MARTELLOS 2004). It is found throughout the British Isles, Scandinavia, Central and Southern Europe, and North America (TIMDAL & JAMES 1992). In Switzerland it has been recorded from altitudes ranging from the colline to the nival vegetation belts of the Swiss Jura mountains and the Northern and Central Swiss Alps (CLERC 2004). This species is new to the cantons of Fribourg and Ticino (Fig. 4). Its presence in the latter marks the first documented occurrence in the Southern Swiss Alps.

Its known ecology is varied; it is often collected on soil associated with calcareous substrata including limestone, epidiorite, chalk and mortar (TIMDAL & JAMES 1992). It commonly grows over bryophytes or plant debris, but may also occur directly on bare soil and occasionally on calcareous rock (CLERC 2004).

Bilimbia lobulata is present and neither rare nor threatened throughout much of continental Europe, except for the Netherlands, where it is considered extinct (APTROOT et al. 1998). It is a frequent species in Switzerland, where its Red List status is LC, indicating that it is not threatened at this time, nor is it in imminent danger of becoming so. In the course of his thesis Vust identified only two specimens

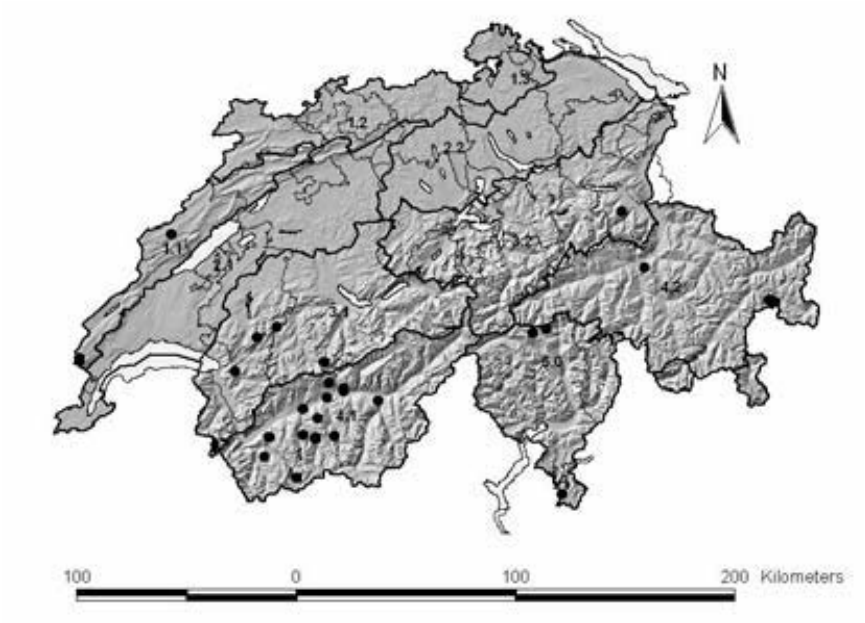

Fig. 4: Known Swiss distribution of *Bilimbia lobulata.*

of this species, leading to the hypothesis that it might be experiencing a regression (VUST 2002). However, our study shows that it is one of the most frequent terricolous crustaceous lichen species in Switzerland, as specimens were collected in all of the biogeographical regions in which it has been historically present, plus the Southern Alps (VAN DEN BOOM & CLERC 2000).

Selected specimens studied: Bern: Engstligenalp, falaise calcaire humide, 608.4/141.975, alt. 2130 m, sur terre nue, 6 septembre 1998, Vust (G); **Fribourg**: Vanil Noir, rocaille calcaire dans un gazon des crêtes ventées, 577.74/153.35, alt. 2270 m, sur bryophytes, 27 octobre 1996, Vust (G); **Graubünden**: Cholschlag, rocaille dans un gazon des crêtes ventées, 743.601/210.101, alt. 2100 m, sur terre nue, 31 août 1998, Vust (G); Parc National, pinède subcontinentale basophile, 811/170.25, alt. 2580 m, sur bryophytes, 17 juin 1997, Vust (G); **Neuchâtel**: Couvet, le Plan du pré, rocaille calcaire sur la crête dans un pâturage, 538.6/200.19, alt. 1120 m, sur bryophytes, 23 octobre 1996, Vust (G); **Ticino**: Arzo, mur de soutènement, 716.8/81.7, alt. 570 m, sur terre nue, 5 mars 1997, Vust (G); **Valais**: Evolène, rocher siliceux moussu dans un éboulis, 604.225/107.775, alt. 1610 m, sur débris de plantes, 5 août 1996, Vust (G); Zinal, Sorebois, rocher calcaire moussu dans une pelouse, 613.05/108.4, alt. 2500 m, sur terre nue, 11 juillet 1998, Vust (G). **Vaud**: Arolière des Lattes, fentes de rocher calcaire dans une végétation des dalles calcaires et lapiez, 568.002/137.502, alt. 1950 m, sur bryophytes, 9 août 1996, Vust (G); La Dôle, pied de mur et rocaille calcaire dans un pâturage, 496.95/142.275, alt. 1650 m; sur bryophytes et terre nue, 31 octobre 1996, Vust (G).

Bilimbia microcarpa (Th.Fr.) Th.Fr. (Syn.: *Bacidia microcarpa* [Th.Fr.] Lettau, *Myxobilimbia microcarpa* [Th.Fr.] Hafellner)

It was difficult to morphologically separate individuals of *Mycobilimbia tetramera* and *Bilimbia sabuletorum* from those of *Bilimbia microcarpa*. However, repeated examinations revealed that specimens of *B. microcarpa* displayed apothecia that quickly become convex, and whose pigment varies from light beige to almost black, similar to those of *B. sabuletorum*; whereas the apothecia of *M. tetramera* are typically wider, flatter, and the dominant pigment is a distinctive reddish-brown hue. In addition, the excipular morphologies of the two genera differ: the *Bilimbia* exciple displays highly gelatinized terminal cells (EKMAN 2004). *Bilimbia microcarpa* and *B. sabuletorum* have similar thalline and apothecial morphology and pigmentation which complicates their separation. However, apothecial sections of *B. microcarpa* show a pale reddish-brown, sometimes spotted epithecium; whereas the epithecium of *B. sabuletorum* is typical-

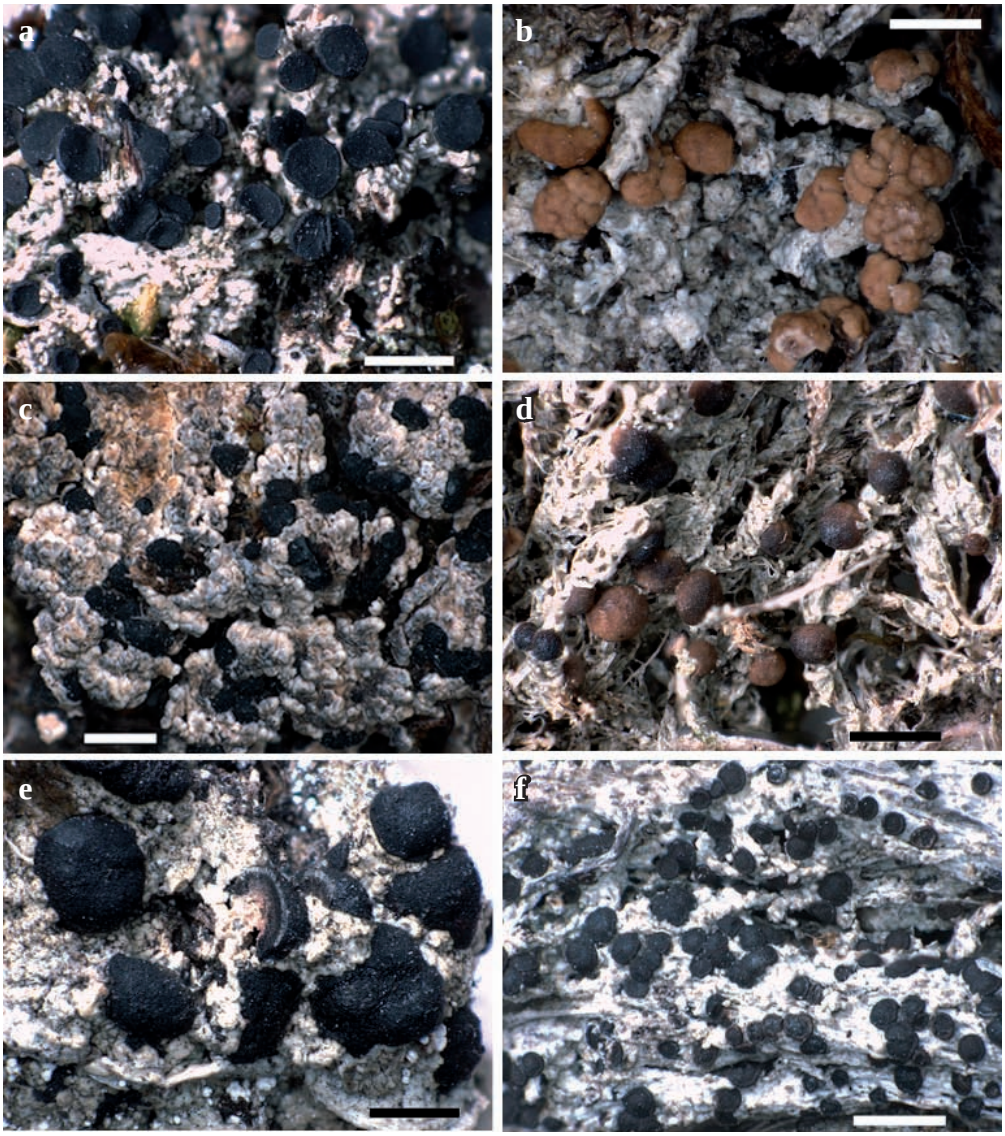

Fig. 5: **a** – *Bacidia bagliettoana*, **b** – *Biatora subduplex*, **c** – *Bilimbia lobulata*, **d** – *B. sabuletorum*, **e** – *Buellia hypophana*, **f** – *B. punctata*. Scale bar = 1 mm.

ly greenish. While both species display subtle spore ornamentation, ascospores of *B. sabuletorum* are most often six to eight-celled; whereas those of *B. microcarpa* have a tendency to be four-celled.

This is an arctic-alpine species known to grow in upland areas, from the Alps to the mountains of Calabria (EKMAN 1996, NIMIS & MARTELLOS 2004). Due to the difficulty with which it is distinguished from many other species, there is most probably much confusion as to this species' true distribution. In Switzerland it has been documented growing at altitudes ranging from the subalpine to the alpine vegetation belt in the Swiss Jura mountains, the Eastern Plateau, and the Eastern Northern and Central Swiss Alps (CLERC 2004). This species is new for the cantons of Uri and Vaud (Fig. 7).

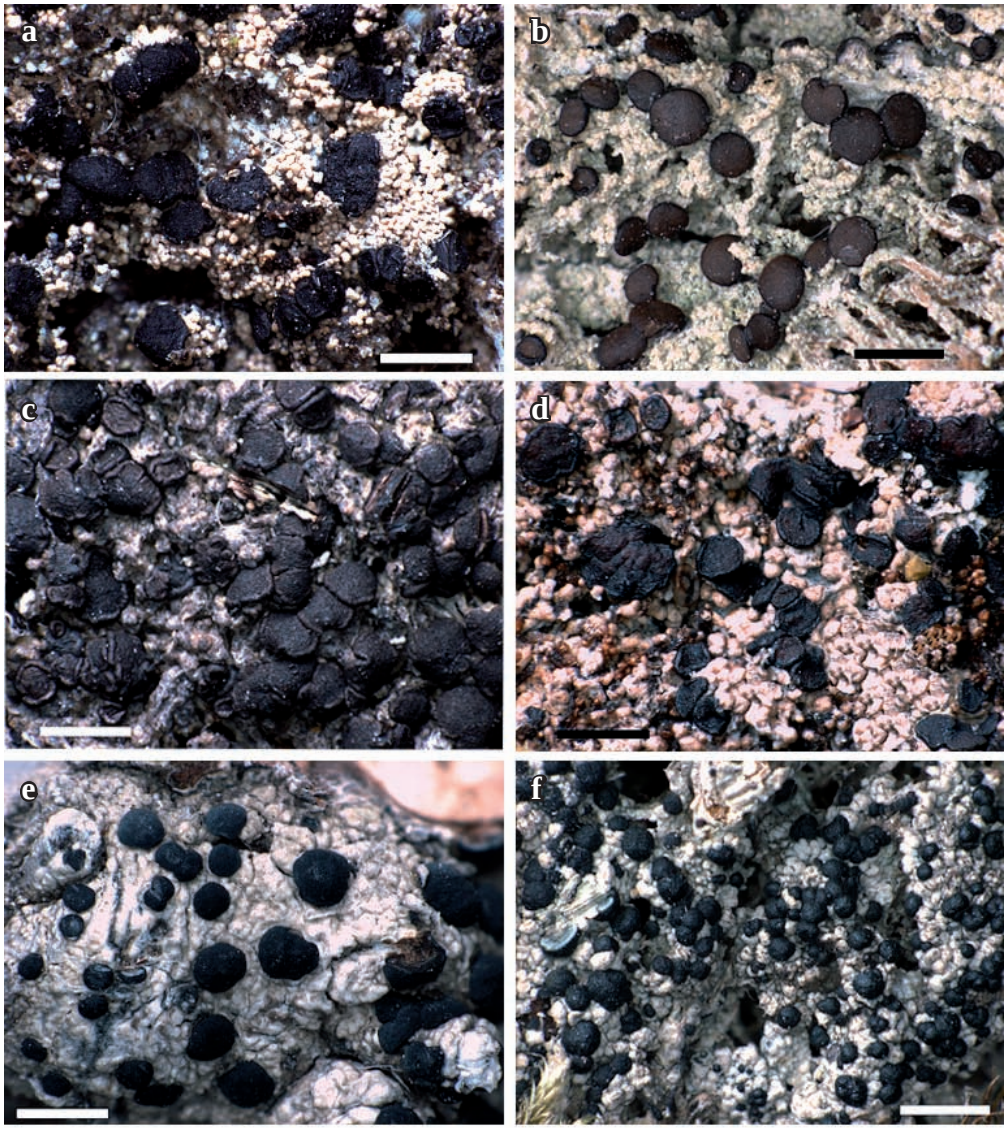

Fig. 6: **a** – *Helocarpon crassipes*, **b** – "*Lecidea*" *berengeriana*, **c** – "*Lecidea*" *hypnorum*, **d** – "*Lecidea*" *rufofusca*, **e** – *Lecidella wulfenii*, **f** – *Micarea lignaria* var. *lignaria*. Scale bar = 1 mm.

Bilimbia microcarpa is known to grow over bryophytes in dry grasslands, and occasionally on mosses growing on old walls (NIMIS & MARTELLOS 2004). Considered primarily terricolous, this species relies on the stability of the muscicolous habitat, as do many of the lichen species discussed in this work. Based on the specimens collected in the course of this project, and due to the fact that the habitats in which the specimens were found were numerous enough and not themselves threatened, this species belongs in the category of least concern (LC).

Selected specimens studied: Graubünden: Feldis, rocaille calcaire dans une lande alpine ventée, 754.45/185.05, alt. 2000 m, sur bryophytes, 5 juin 1999, Vust (G); **Neuchâtel**: Le Locle, le Saignolet, mur de pierres sèches dans un pâturage, 549.15/215.7, alt. 1240 m, sur débris de plantes, 24 octobre 1996, Vust (G); **Uri**: Isenthal, rocher calcaire

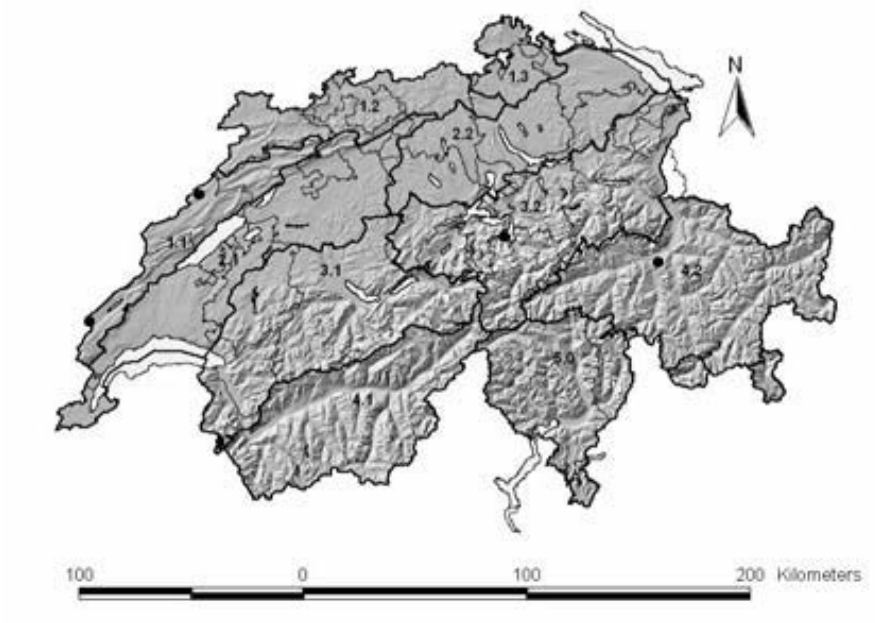

Fig. 7: Known Swiss distribution of *Bilimbia microcarpa.*

moussu dans une hêtraie à sapins, 685.175/196.55, alt. 1020 m, sur bryophytes et débris de plantes, 12 mai 1998, Vust (G); **Vaud**: Risoux, talus de route et rochers dans une pessière, 500.35/158.675, alt. 1230 m, sur bryophytes et débris de plantes, 20 octobre 1996, Vust (G).

Bilimbia sabuletorum (Schreb.) Arnold (Syn.: *Bacidia sabuletorum* [Schreb.] Lettau, *Mycobilimbia sabuletorum* [Schreb.] Hafellner, *Myxobilimbia sabuletorum* [Schreb.] Hafellner)

The following characteristics were especially useful for determination: the thin beige-grey thallus forming a thin layer over bryophyte debris, variable apothecia colour, whereby apothecia of colours ranging from light brown to almost black occurred on the same thallus (Fig. 5d), the green epithecia, and the dark reddish-brown hypothecia. Specimens were distinguished from *B. lobulata* due to the differences in thallus appearance and the ascospore size and septation; ascospores of *B. sabuletorum* vary from two- to five-septate and reach lengths of up to 40–50 µm, whereas those of *B. lobulata* vary from non- to three-septate and reach lengths of up to 26 µm. See under *B. microcarpa* for differences with this species.

The combination of thallus morphology, bryophyte and/or plant debris substrata, and the variable apothecial pigmentation provide useful tools for differentiating this species in the field.

This species is common throughout Europe, North America, and New Zealand (COPPINS 1992a). It is considered a holarctic, mainly temperate species by NIMIS & MARTELLOS (2004), and is most common at low altitudes.

Its distribution in Switzerland is relatively homogenous, with documented localities in all of the natural regions except the Southern Swiss Alps and the northwestern part of Switzerland (CLERC 2004). It is equally homogenous in its altitudinal distribution, with documented localities at altitudes of less than 600 m as well as some found at 2100 m, although most localities are documented below the subalpine vegetation belt. Individuals have been identified from most of the cantons where this species has been historically present, and the identification of several individuals in the cantons of Neuchâtel, Obwald, and Sankt-Gallen mark this species' first documented appearances in these cantons (Fig. 8).

Bilimbia sabuletorum is usually collected "on mosses or plant debris over calcareous rocks, stonework, or turf, rarely directly on rock, occasionally on shaded trunks of old trees" (COPPINS 1992a). Many of

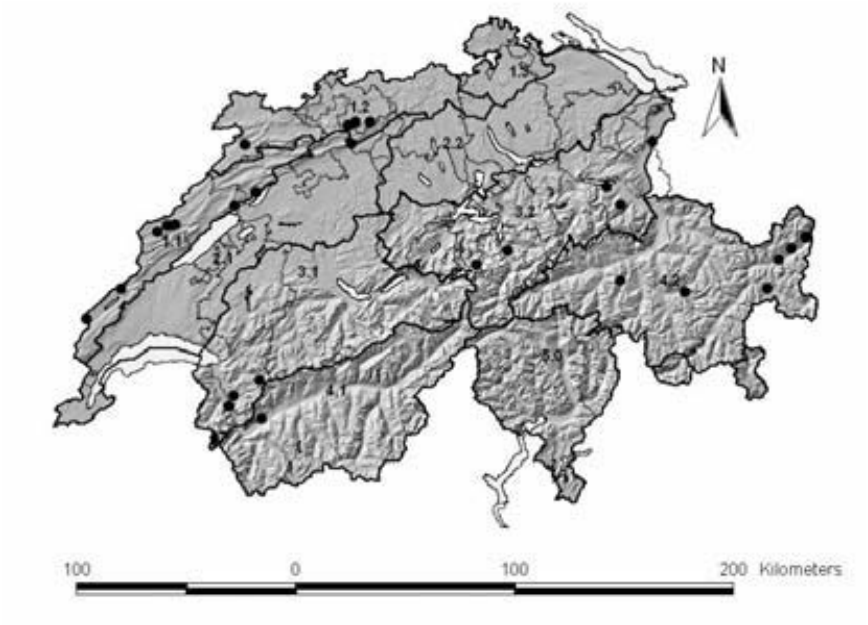

Fig. 8: Known Swiss terricolous distribution of *Bilimbia sabuletorum*.

the specimens identified were collected on mosses or plant debris over calcareous rock, confirming the already known substrate preferences of this species.

When the epiphytic distribution (STOFER et al. 2003) is compared to the terricolous distribution, it becomes obvious that terricolous specimens are missing from the Swiss Plateau. This is due to human activities, which eliminate terricolous lichen habitat. The ability to grow on tree trunks gives this species the opportunity to grow on the Plateau. This species has been included in the Epiphytic Lichens Red List (SCHEIDEGGER et al. 2002), where its category is LC. Our study corroborates this conclusion, indicating that its presence in Switzerland is not threatened.

Selected specimens studied: Bern: Ligerz, mur de pierres sèches, 577.55/215.775, alt. 590 m, sur bryophytes, 13 juin 1999, Vust (G); **Basel-Land**: Waldenburg, rocaille calcaire dans une chênaie buissonnante, 623.1/248.075, alt. 690 m, sur bryophytes, 15 juin 1999, Vust (G); **Graubünden**: Cholschag, rocaille calcaire dans un gazon des crêtes ventées, 743.601/210.101, alt. 2100 m, sur bryophytes, 31 août 1998, Vust (G); Tchlin, gros rocher dans une pinède continentale xérophile, 828.7/195.55, alt. 1290 m, sur bryophytes, 13 juin 1998, Vust (G); **Jura**: Montfaucon, mur de pierres sèches, moussues dans un pâturage, 572.825/237.775, alt. 925 m, sur bryophytes, 24 avril 1998, Vust (G); **Neuchâtel**: Couvet, Mont-Brenin, mur de pierres sèches, 537.02/200.8, alt. 1120m, sur bryophytes, 23 octobre 1996, Vust (G); **Sankt-Gallen**: Rüthi, rocaille calcaire, 758.775/239.4, alt. 450 m, sur bryophytes, 14 octobre 1998, Vust (G); **Solothurn**: Passwang, talus de voie linéaire dans une hêtraie mésophile, 619.9/246.6, alt. 1100 m, sur bryophytes, 29 avril 1998, Vust (G); **Unterwald (Obwalden)**: Engelberg, rocher calcaire moussu dans un pâturage, 678.15/183.35, alt. 1170 m, sur bryophytes, 14 mai 1998, Vust (G); **Uri**: Schattdorf, rocaille calcaire dans une forêt de feuillus, 692.55/189.8, alt. 650 m, sur bryophytes, 12 mai 1998, Vust (G); **Valais**: Saillon, talus éboulé dans une pelouse steppique, 580.225/113.325, alt. 510 m, sur terre nue, avril 1995, Vust (G); **Vaud**: Bex, talus de vigne, 567.55/123.76, alt. 525 m, sur bryophytes, avril 1996, Vust (G); Vallorbe, falaise dans une hêtraie mésophile, 515.85/172.2, alt. 990 m, sur bryophytes, 9 juillet 1996, Vust (G).

Buellia hypophana (Nyl.) Zahlbr.

Diagnostic for this species are the colorless epithecium interspersed with droplets of brownish oil, the dark reddish-brown hypothecium (Fig. 5e), and the small, one-septate ascospores turning brown at maturity. Specimens were distinguished from *Buellia papillata* due to their smaller ascospores, their

Fig. 9: **a** – *Micarea peliocarpa* (scale bar = 0.5 mm), **b** – *Mycobilimbia carneoalbida*, **c** – *Mycobilimbia tetramera*, **d** – *Protomicarea limosa*. Scale bar = 1 mm.

typically smaller apothecia, and the darkly pigmented hypothecium; and from *B. punctata* due to the latter's larger and longer ascospores.

This species has been documented growing in the subalpine vegetation belt in the western part of the Central Swiss Alps (CLERC 2004). It can be found growing above the treeline over mosses or plant debris, or as an epilithic species (CLERC 2004, NIMIS & MARTELLOS 2004).

Buellia hypophana is either rare, or poorly known, or both. It is present in only a few European countries including Switzerland, Austria, and Germany, where it is threatened (see Table 2). Its known distribution in Switzerland is so far restricted to the canton of Valais (Fig. 10), where it is typically collected in high-altitude, relatively dry grasslands. Of the three specimens identified in the course of this project, one was collected in a threatened habitat, a Mesobromion. This factor combined with this species' relative rarity increases its level of threat to endangered (EN).

Specimens studied: Valais: Chemin, rocaille siliceuse dans une pelouse mi-sèche, 574.55/104.6, alt. 1400 m, sur débris de plantes, 31 juillet 1996, Vust (G); Randa, rocaille siliceuse dans une pelouse steppique, 627.15/104.7, alt. 1720 m, sur débris de plantes, 15 juillet 1998, Vust (G); Ausserberg, pelouse steppique, 632.35/129.925, alt. 1170 m, sur bryophytes et débris de plantes, 27 avril 1999, Vust (G).

Buellia papillata (Sommerf.) Tuck.

The specimens were identified due to the one-septate ascospores turning brown at maturity and the white thallus composed of thickish, rounded areoles. This species is distinguished from *Buellia insignis* due mainly to its shorter, narrower ascospores (NORDIN 2004).

This is an arctic-alpine species found mostly near or above the treeline (NIMIS & MARTELLOS 2004). In Switzerland, this species is restricted to the subalpine and alpine vegetation belts of the Central Alps

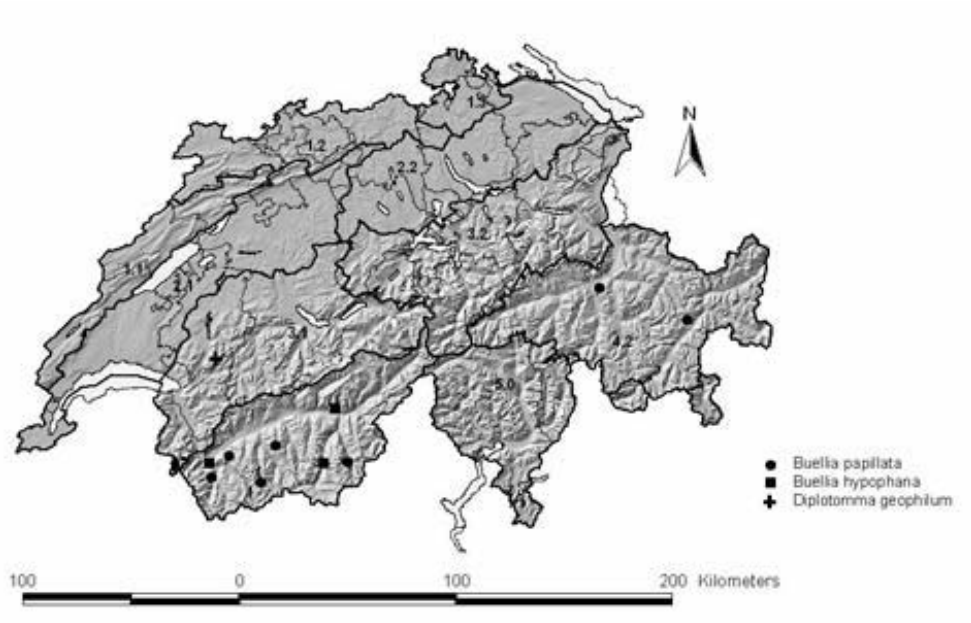

Fig. 10: Known Swiss distributions of *Buellia hypophana*, *B. papillata* and *Diplotomma geophilum*.

(CLERC 2004). It is associated with mosses and plant debris over soil or rocks, both calcareous and siliceous.

The current specimens were found in the cantons of Graubünden and Valais (Fig. 10), where this species has been collected historically. Although poorly known and not common, this species is present throughout much of Northern and Western Europe, where it is neither rare nor threatened. It is absent from Great Britain, and is classified as threatened in Slovakia (Table 2). We attribute the category of least concern (LC) to this species because it was collected in A relevés in non-threathened habitats.

Selected specimens studied: Graubünden: Piz Fourun, rocaille siliceuse dans une lande alpine ventée, 794.902/170.451, alt. 2840 m, sur bryophytes, 2 août 1998, Vust (G); **Valais**: Champex, rocher siliceux moussu dans une pessière, 575.55/98.025, alt. 1720 m, sur bryophytes, 22 août 1996, Vust (G); Vallon de Réchy, sous la pointe de Tsavolire, terre nue dans un éboulis de roches calcaires, 605/112.65, alt. 2800 m, sur bryophytes, 15 août 1996, Vust (G).

Buellia punctata (Hoffm.) A.Massal. (Syn.: *Amandinea punctata* [Hoffm.] Coppins & Scheid.)

This species was identified due to its thin, grey thallus, its small and numerous dark apothecia (Fig. 5f), and its large two-septate ascospores becoming brown at maturity. In addition to these characters, the lack of hymenial oil droplets confirmed its identification. POELT (1969) considered that individuals collected over mosses or plants remains belonged to the taxon *B. punctata* f. *muscicola* Hepp ex. Körb. em. Arnold. However, the substratum differences notwithstanding, no criteria seem to support this segregation.

This species is very common, and is considered "almost cosmopolitan" by NIMIS & MARTELLOS (2004). It can grow on a wide variety of substrata, and has been documented in epiphytic, terricolous, and saxicolous habitats. It is not limited to a specific altitude range. It has been abundantly documented growing throughout Switzerland in all of the biogeographical regions, from the low altitudes of the plain to the alpine vegetation belt (CLERC 2004). The Swiss distribution of the epiphytic specimens collected during the Lichen Red List project is given by STOFER et al. (2003).

Six specimens were collected on terricolous substrata in the course of the inventory made by VUST (2002), of which four were identified here. All four were collected over mosses or plant debris.

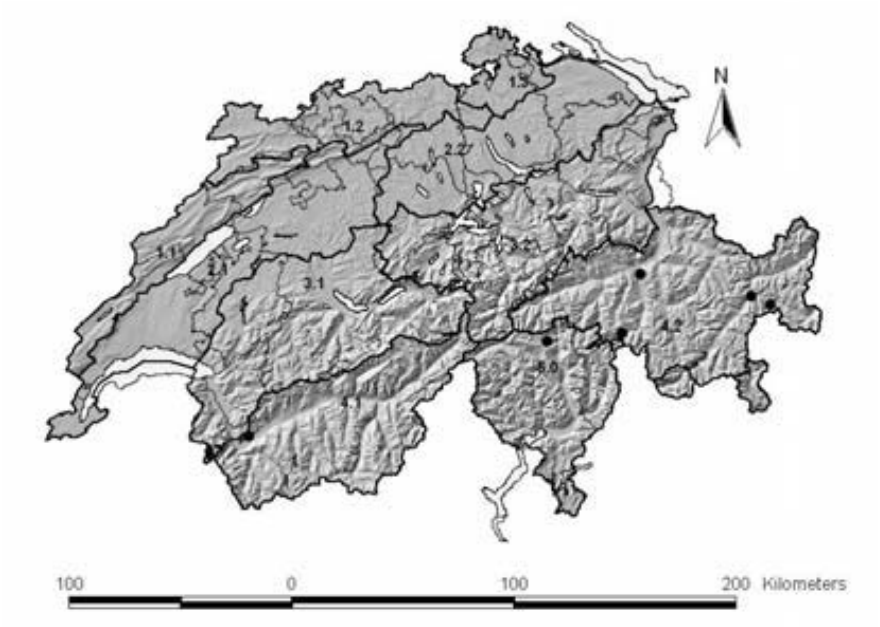

Fig. 11: Known Swiss terricolous distribution of *Buellia punctata*.

However, the terricolous specimens represent only a small fraction of the real Swiss distribution; indeed, 399 specimens were identified during the course of the Epiphytic Lichens Red List project (STOFER et al. 2003), compared to the six terricolous specimens discovered. Interestingly, terricolous specimens were only found growing in the Central or Southern Alps (Fig. 11), whereas epiphytic specimens are much more homogeneously distributed among the different biogeographical regions and the Swiss cantons (STOFER et al. 2003).

Due to its ability to grow on various substrata in a wide variety of conditions, this species' distribution and success results in its being classified as LC in the Epiphytic Lichens Red List (SCHEIDEGGER et al. 2002). We reach the same conclusion when considering uniquely the terricolous specimens.

Specimens studied: Graubünden: Feldis, rocaille calcaire dans une prairie de fauche, 752.151/184.351, alt. 1440 m, sur débris lignifiés de plantes, 6 juin 1999, Vust (G); Parc national, pinède subcontinentale basophile, 811/170.25, alt. 2050 m, sur bryophytes et débris de plantes, 17 juin 1997, Vust (G); **Valais**: Mazembroz, pelouse steppique, 576.55/111.6, alt. 600 m, sur bryophytes, 27 avril 1995, Vust (G); **Ticino**: Lucomagno, sous Döpra, talus de voie linéaire dans une prairie de fauche, 710.75/154.2, alt. 1780 m, sur débris lignifiés de plantes, 22 juillet 1993, Vust (G).

Diplotomma geophilum (Sommerf.) D.D.Awasthi & S.R.Singh (Syn.: *Buellia geophila* [Sommerf.] Lynge)

This species was identified due to its three-septate ascospores becoming brown at maturity, and by the terricolous ecology (NORDIN 2000). The identification was verified by TLC, which detected the presence of 6-O-methylarthothelin.

This is a mainly (sub)arctic-alpine species whose altitudinal range varies according to the latitude: in the southern parts of its distribution (Central Europe) it only occurs at high altitudes (c. 1600–1800 m), whereas in the northern parts (Fennoscandia and the arctic tundra area) it is also found at lower altitudes. It is present though rare throughout most of continental Europe (NORDIN 2000).

In Switzerland this species has been recorded growing in the montane and subalpine vegetation belts of the Northern and Central Swiss Alps as well as in the western part of the Swiss Jura mountains. Historically documented in the Swiss cantons of Graubünden, Vaud, Valais, and Zug (CLERC 2004),

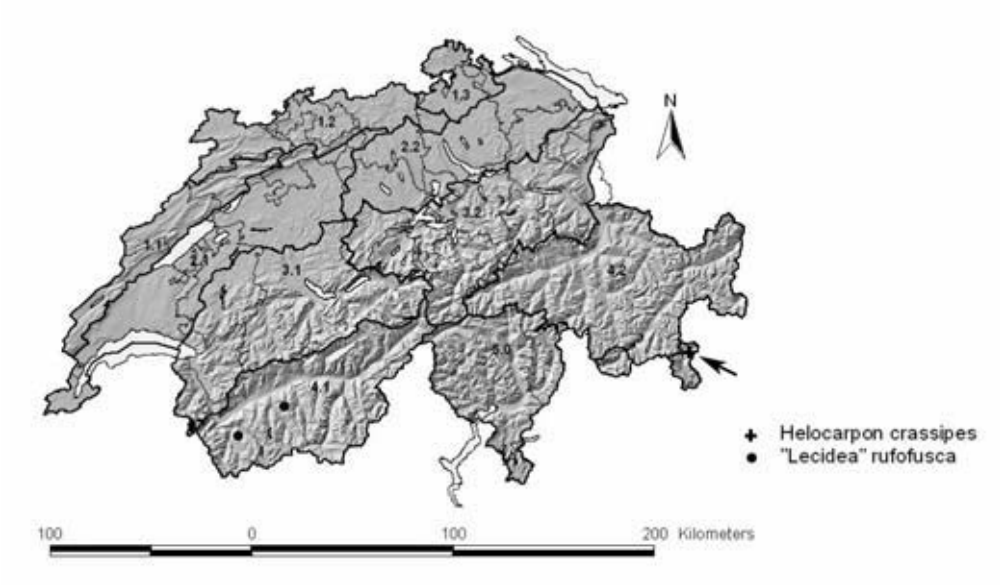

Fig. 12: Known Swiss distributions of *Helocarpon crassipes* and "*Lecidea*" *rufofusca.*

this species was found growing in the canton of Fribourg in the western part of the Northern Swiss Alps (Fig. 10). This location is this species' first documented appearance in both the canton and the biogeographical region.

Diplotomma geophilum is a terricolous lichen overgrowing mosses and other lichens on a variety of soil types, from acidic to basic (CLERC 2004). The specimen was collected at a high altitude on plant debris located in a wind-exposed site.

The discovery of a single specimen among the relevé B samples contributes to this species being classified as near threatened (NT). Although not considered to be under immediate threat, the relative rarity of this species makes it susceptible to decline. While present and neither rare nor threatened in much of Western Europe, it is considered rare in Italy (Table 2).

Specimen studied: Fribourg: Vanil Noir, gazon des crêtes ventées, 577.725/153.15, alt. 2370 m, sur débris de plantes, 27 octobre 1996, Vust (G).

Helocarpon crassipes Th.Fr. (Syn.: *Micarea crassipes* [Th.Fr.] Coppins)

This species was identified due to its distinctive thallus morphology, especially the numerous secondary granules, the shape of the apothecia, which varies from flat with a well-developed true excipulum when young to concave with an often excluded excipulum when old (Fig. 6a), and the non- to one-septate ascospores. The identification was confirmed by the K+ green (intensifying) reaction of the excipulum and the K+ purple reaction of the upper hymenium (COPPINS 1992c).

This is an arctic-alpine species growing over mosses on summit rocks, or on the ground over mosses or plant debris (BREUSS 2001, CLERC 2004, COPPINS 1992c). This species is rare in Switzerland, which is perhaps one of the reasons for which only one specimen was found in the course of this project. It has been previously collected on humus in a subalpine *Picea* forest on Albulapass, Graubünden (DIETRICH et al. 1992), located in the Eastern Central Swiss Alps. The specimen identified for this paper was also found in Graubünden; however its locality is further south, in the Southern Swiss Alps, representing the first report of this species in this biogeographical region (Fig. 12).

Helocarpon crassipes is considered threatened in Great Britain and Slovakia, and is absent from Germany, Italy, the Netherlands, Finland and Sweden (Table 2). Though rare in Switzerland, the collection of this

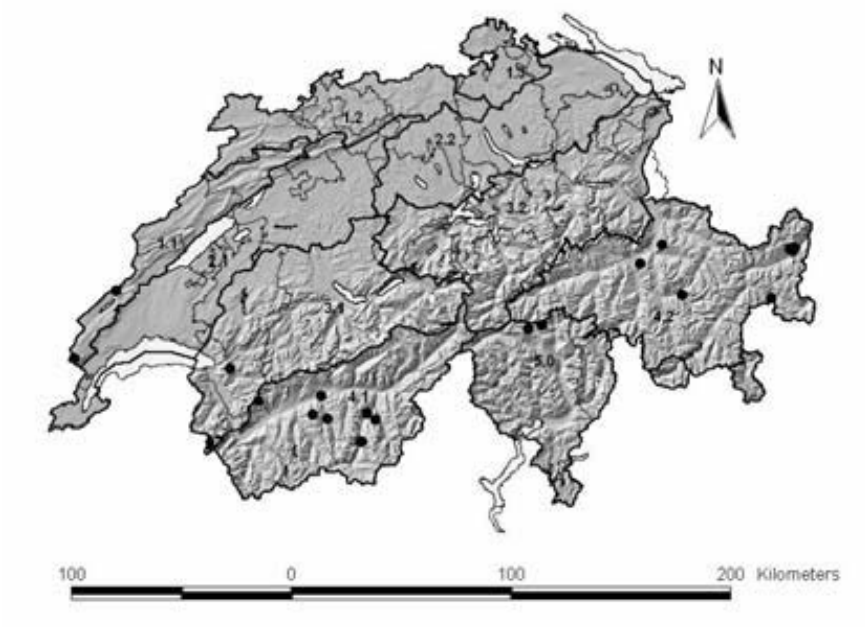

Fig. 13: Known Swiss distribution of "*Lecidea*" *berengeriana*.

species during the statistically sampled fieldwork indicates that this rarity does not constitute the reflection of an ecological threat. This species can be classified as being of least concern (LC) in Switzerland.

Specimen studied: Graubünden: Val Poschiavo, forêt de mélèzes et d'arolles, 805.72/140.72, alt. 2000 m, sur débris de plantes et terre nue, 1 août 1998, Vust (G).

"Lecidea" berengeriana (A.Massal.) Th.Fr. (Syn.: *Mycobilimbia berengeriana* [A.Massal.] Hafellner & V.Wirth)

This species is distinguished from *Mycobilimbia tetramera* and *Bilimbia sabuletorum* by its non-septate ascospores, from *"Lecidea" hypnorum* by differing thallus morphology (Fig. 6b) and colour, a dominantly brown rather than greenish-hued epihymenium, and the lack of blue K+ green spots throughout the hymenium, and from *Lecidella alpestris* (Sommerf.) Körb. due to the larger ascospores and the brownish rather than greenish epihymenium.

"*Lecidea*" *berengeriana* is circumpolar in the mountains of the Northern Hemisphere (HAWKSWORTH & COPPINS 1992) and has also been documented in the Sonoran Desert Region (HERTEL & PRINTZEN 2004). It is found growing at altitudes ranging from the colline to the alpine vegetation belts. In Switzerland it has been historically reported growing in the Jura mountains, in the Northern Alps, and in the eastern part of the Central Swiss Alps (CLERC 2004). It is new to the cantons of Valais and Ticino (Fig. 13), marking its first appearance in the biogeographical regions of the Western Central Alps and the Southern Alps, respectively. It was neither found in the Northern Jura nor in the eastern part of the Northern Alps, regions in which its presence has been documented historically. The absence of this species from the Swiss Plateau reflects inherent ecological restrictions rather than a regression, since it is a species typical of mountain ridges (HAWKSWORTH & COPPINS 1992).

This species is typically collected on bryophytes on calcareous rocks or directly on bare calcareous soil (HAWKSWORTH & COPPINS 1992). Several of the specimens identified here were collected on mosses over rock piles, in situations where disturbances are common and bryophytes or plant debris provide the stability necessary for the development of the lichen.

Although threatened in Slovakia, this species is present but neither rare nor threatened in most of Western Europe (Table 2). The case is similar in Switzerland, where identification of this species in several locations attests to its presence and results in being classified as LC.

Selected specimens studied: Graubünden: Filisur, talus de voie linéaire dans une pessière, 773.526/170.601, alt. 1600 m, sur bryophytes, 24 avril 1998, Vust (G); Ramosch, talus de voie linéaire dans une pessière, 824.811/191.926, alt. 1500 m, sur bryophytes, 10 juin 1998, Vust (G); **Ticino**: Lucomagno, rocher calcaire moussu dans un pâturage gras, 703.2/155.05, alt. 2145 m, sur bryophytes, 22 juillet 1997, Vust (G); **Valais**: Derborence, Derbon, rocaille calcaire dans un gazon des crêtes ventées, 580.9/122.55, alt. 2070 m, sur bryophytes et terre nue, 16 juillet 1997, Vust (G); Randa, bloc siliceux parmi les rhododendrons dans un mélézein, 627.841/104.561, alt. 2130 m, sur bryophytes et terre nue, 15 juillet 1998, Vust (G); Vallon de Réchy, rocher calcaire moussu dans une lande méso-hygrophile sur sol acide, 605.425/116.375, alt. 2200 m, sur bryophytes, 14 août 1996, Vust (G); **Vaud**: La Dôle, rocaille calcaire dans un pâturage, 496.8/142.05, alt. 1630 m, sur bryophytes, 31 octobre 1996, Vust (G).

"Lecidea" hypnorum Lib. (Syn.: *Mycobilimbia hypnorum* [Lib.] Kalb & Hafellner)

This species was easily identifiable due to its often greenish epihymenium and its colourless hymenium with characteristic greenish intensifiying K+ blue spots. The presence of a reddish-brown subhymenium and ascospore dimensions further confirmed the determination. The thallus is typically brown, although it may vary from light to dark-coloured, and consists of a thin, discontinuous layer of granules of varying size and shape (Fig. 6c), looking "dirty" under a stereomicroscope or hand lens.

"*Lecidea hypnorum*" is a cool-temperate to arctic-alpine, probably circumpolar lichen (NIMIS & MARTELLOS 2004). It has historically been found throughout Switzerland growing at a large range of altitudes from the colline to the alpine vegetation belt (CLERC 2004). It is typically collected on bryophytes or plant debris, most often on calcareous soil, and occasionally on old tree trunks (HAWKSWORTH & COPPINS 1992).

It has been previously found growing in the cantons of Basel, Bern, Genève, Graubünden, Luzern, Ticino, Uri, Unterwald, Vaud, and Valais (CLERC 2004). Specimens determined here were collected in the cantons of Vaud, Valais and Graubünden (Fig. 14). This species is common, and though threatened in Slovakia (Table 2), it should be included in the Red List category LC in Switzerland.

Selected specimens studied: Graubünden: Cholschlag, rocaille calcaire dans un gazon des crêtes ventées, 743.601/210.101, alt. 2100 m, sur bryophytes et terre nue, 31 août 1998, Vust (G); Innerferrera, rocher siliceux moussu dans une lande subalpine xérophile, 752/152, alt. 1850 m, sur bryophytes et débris de plantes, 29 août 1998, Vust (G); Montalin, butte dans un pâturage gras, 764.751/193.026, alt. 2160 m, sur débris de plantes et terre nue, 30 août 1998, Vust (G); **Valais**: Les Violettes, rocaille calcaire dans un gazon des crêtes ventées, 604.525/132.325, alt. 2250 m, sur bryophytes et terre nue, 5 août 1997, Vust (G); Mayens de Bruson, gypse dans un gazon des crêtes ventées, 581.025/99.45, alt. 2095 m, sur bryophytes et terre nue, 1 juillet 1997, Vust (G); **Vaud**: Risoux, talus de route ± rocailleux et calcaire, dans une hêtraie à sapins, 500.525/158.9, alt. 1210 m, sur bryophytes et débris de plantes, 20 octobre 1996, Vust (G); Corne des Brenlaires, rochers siliceux moussus dans pâturage gras, 576.551/140.276, alt. 1700 m, sur bryophytes, 16 juin 1999, Vust (G).

"Lecidea" rufofusca (Anzi) Nyl.

This species was identified due to its typically reddish-brown epithecium (Fig. 6d), the easily visible, persistent true exciple, the one-septate ascospores, and the unique shape of its paraphyses. These last have a crooked, almost wavy appearance and are capped by a round, thickened apex. This species probably belongs to a still undescribed genus.

This is a rare and poorly known arctic-alpine species. In Switzerland its known distribution is limited to high altitudes corresponding to the alpine and nival vegetation belts of the Central Swiss Alps and the western part of the Northern Swiss Alps (CLERC 2004).

"*Lecidea*" *rufofusca* is typically collected over terricolous bryophytes or plant debris in siliceous areas (NIMIS & MARTELLOS 2004). All three specimens were growing on mosses or plant debris in alpine grasslands, a vegetation type dominated by herbaceous and ericaceous species that grow sparsely enough to allow terricolous lichen growth (VUST 2002).

This species has been previously documented in the Swiss cantons of Graubünden, Uri, and Valais (CLERC 2004). All specimens were growing from the canton of Valais (Fig. 12). These identifications were exciting discoveries, since this species is rare. This rarity and not the threat of disappearing habitats explain this species' limited distribution. In the case of "*Lecidea*" *rufofusca*, finding suitable con-

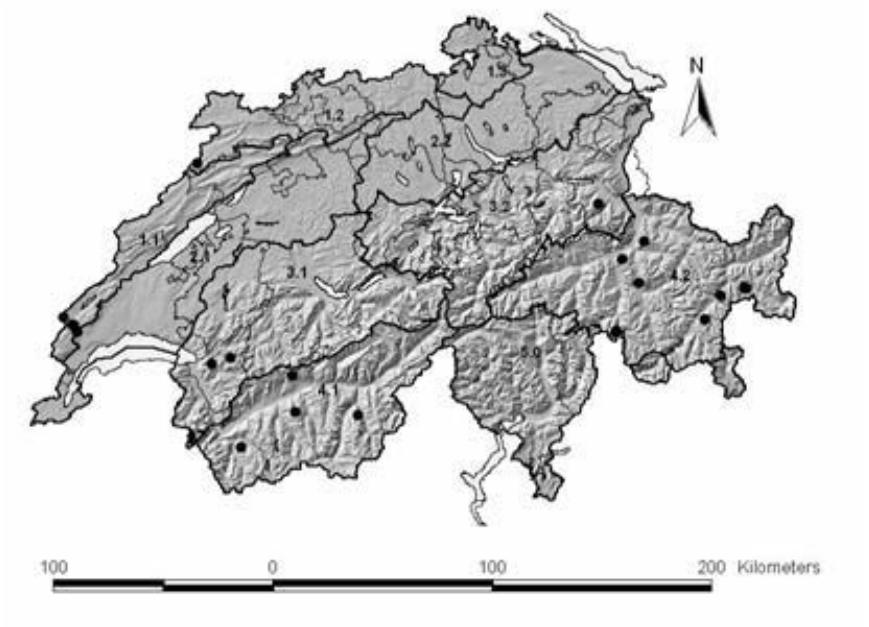

Fig. 14: Known Swiss distribution of "*Lecidea*" *hypnorum*.

ditions is more limited by appropriate climatic conditions and competition from vascular plants than by the influence of human activities or habitat availability. Since it was collected in A and B relevés in non-threathened habitats, this species belongs in the category LC.

Specimens studied: Valais: Mayens de Bruson, lande xérophile sur sol acide, 581.5/99.1, alt. 2100 m, sur débris de plantes, 1 juillet 1997, Vust (G); Vallon de Réchy, combe à neige calcaire, 604.575/113.775, alt. 2600 m, sur bryophytes et terre nue, 15 août 1996, Vust (G); Vallon de Réchy, combe à neige calcaire, 604.575/113.775, alt. 2600 m, sur bryophytes, 15 août 1996, Vust (G).

Lecidella wulfenii (Hepp) Körb.

This species is characterized by its distinctive thallus morphology (Fig. 6e), the greenish epithecium, the reddish-brown hypothecium, the non-septate hyaline spores, and the distinctive ecology. Specimens can be distinguished from *Lecidella alpestris* by the presence of atranorin and various xanthones (KC+ yellowish-orange) (KNOPH & LEUCKERT 1997).

Lecidella wulfenii is a circumpolar, arctic-alpine lichen present in North America, throughout Europe and most probably in the high mountains of the south (NIMIS & MARTELLOS 2004). In Switzerland it has been recorded growing at altitudes ranging from the montane to the alpine vegetation belts of the Northern and Central Swiss Alps (CLERC 2004). It was found in the canton of Ticino and thereby in the Southern Swiss Alps for the first time in the course of this study (Fig. 15).

This species typically grows on moribund bryophytes and plant debris in exposed habitats at high altitudes, near or above the treeline (NIMIS & MARTELLOS 2004). It is most typical of calcareous substrata (PURVIS & JAMES 1992). The locations where the specimens were found reflect these preferences: all were wind-exposed alpine habitats.

Lecidella wulfenii is known to be present and neither rare nor threatened in other European countries including Germany, Great Britain, Italy, Austria, Finland, Sweden, and Slovakia (Table 2). Since more than three occurrences were found in B relevés in non-threathened habitats, this species is assigned to the category LC.

Selected specimens studied: Ticino: Val de Campo, rocaille calcaire dans un gazon des crêtes ventées, 709.5/157.05, alt. 2100 m, sur débris de plantes, 25 juillet 1997, Vust (G); **Valais**: Montana, Les Violettes, rocher calcaire dans un

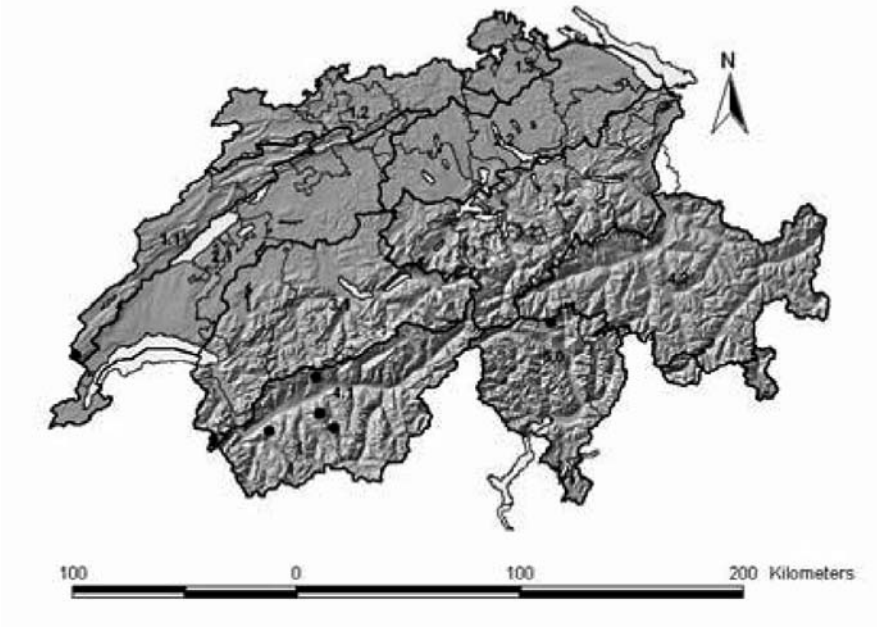

Fig. 15: Known Swiss distribution of *Lecidella wulfenii*.

gazon des crêtes ventées, 604.525/132.325, alt. 2250 m, sur bryophytes et débris de plantes, 5 août 1997, Vust (G); Savoleyres, doline de gypse dans une pelouse calcaire sèche, 583.35/108.15, alt. 2270 m, sur débris de plantes, 3 août 1997, Vust (G); Vallon de Réchy, rocaille calcaire dans un gazon des crêtes ventées, 605.85/115.875, alt. 2370 m, sur débris de plantes, 15 août 1996, Vust (G); Zinal, Sorebois, lande alpine ventée, 612.7/109.7, alt. 2460 m, sur bryophytes et débris de plantes, 11 juillet 1998, Vust (G); **Vaud**: La Dôle, rocaille calcaire dans une pelouse calcaire sèche, 497.05/142.15, alt. 1620 m, sur débris de plantes ligneuses, 31 octobre 1996, Vust (G).

Lopadium pezizoideum (Ach.) Körb.

This species was identified due to its distinctive dark brown thallus and its large, muriform ascospores.

Present throughout much of Europe, North America, and Japan, this is a relatively common circumboreal montane species (NIMIS & MARTELLOS 2004). In Switzerland it is known to grow at altitudes ranging from the montane to the subalpine vegetation belts of the Swiss Jura mountains and the Northern and Central Swiss Alps (CLERC 2004).

Lopadium pezizoideum is typically collected on moribund bryophytes and plant debris over siliceous rocks, and occasionally over bare soil (NIMIS & MARTELLOS 2004). The locations of the specimens identified in the course of this project are consistent with this description and show clear acidophilic tendencies.

Two of the four specimens identified for this project were found growing in the canton of Graubünden, and the remaining two in the canton of Valais (Fig. 16). Historically present in the Jura Mountains and the Northern Swiss Alps, this species may be experiencing a regression of its distribution. This remains to be proved however, and the current situation allows us to attribute *Lopadium pezizoideum* to the category LC.

Selected specimens studied: Graubünden: La Punt-chamues-ch, rocaille siliceuse dans une lande méso-hygrophile sur sol acide, 792/158, alt. 2260 m, sur bryophytes et débris de plantes, 4 août 1998, Vust (G); **Valais**: Herbriggen (Natterdul), rocaille siliceuse dans une lande méso-hygrophile, 625/109, alt. 2250 m, sur bryophytes et débris de plantes, 16 juillet 1998, Vust (G); Mandelon, lande xérophile sur sol acide, 598.65/108, alt. 2400 m, sur débris de plantes et terre nue, 9 août 1995, Vust (G).

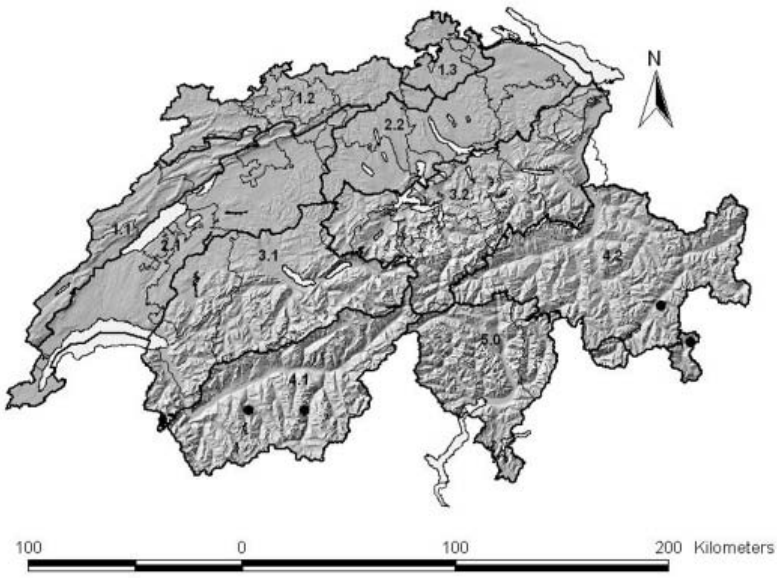

Fig. 16: Known Swiss distribution of *Lopadium pezizoideum.*

Micarea lignaria (Ach.) Hedl. var. ***lignaria***

Diagnostic for this species are the distinctive green epithecium (Fig. 6f), the olivaceous hymenium, and the four- to eight-celled ascospores (NIMIS & MARTELLOS 2004). The Pd+ orange thalli confirmed the identification of the *lignaria* variety. This was further confirmed by the presence of argopsin (TLC).

This is a "widespread, temperate to boreal-montane species", the most common of the genus in Italy (NIMIS & MARTELLOS 2004). It has been recorded growing in the biogeographical regions of the Western Jura mountains, the Swiss Plateau, and the western part of the Central Swiss Alps from altitudes ranging from the colline to the alpine vegetation belt (CLERC 2004).

The specimens identified here were all found at altitudes ranging from the colline to the montane vegetation belt. Previous discoveries of *Micarea lignaria* var. *lignaria* have found individuals at altitudes as high as 1860 m in the canton of Valais (VAN DEN BOOM et al. 1993). It is new for the cantons of Ticino and Graubünden (Fig. 17). Five of the seven specimens identified here were collected in Ticino and one was found in Graubünden; these six localities are in the Southern Swiss Alps and show a certain preference for relatively warm, humid conditions. Three of the five specimens were located in *Fagus* forests in the montane to subalpine vegetation in the Southern Alps, a landscape relatively poor in terricolous lichens (VUST 2002). It is sometime found growing epiphytically; the distribution of these specimens in Switzerland is given by STOFER et al. (2003).

Typically found on a variety of substrata, including bryophytes, plant debris, bark and lignified plant remains, *M. lignaria* var. *lignaria* rarely grows directly on bare soil (CLERC 2004, NIMIS & MARTELLOS 2004). All of the specimens identified here were collected over bryophytes and/or plant debris.

This is a widespread and common species throughout Europe, but its level of threat is not well known. This species was not considered in the Swiss Lichen Red List (CLERC & VUST 2002). Analysis of its current distribution allows it to be classified as LC.

Selected specimens studied: Graubünden: Monti di Arvigo, rocher siliceux moussu dans pessière, 727.9/128.4, alt. 1630 m, sur bryophytes et débris de plantes, 21 juin 1996, Vust (G); **Ticino**: Lodrino, rocher siliceux moussu dans une pessière, 715/125, alt. 1145 m, sur bryophytes et débris de plantes, 19 août 1998, Vust (G); Maggia, ro-

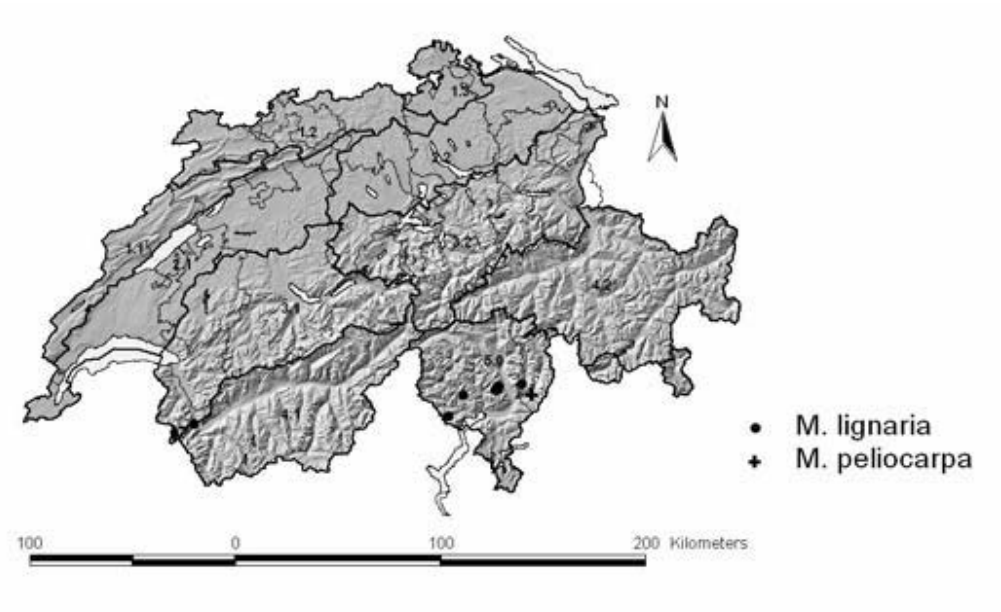

Fig. 17: Known Swiss terricolous distribution of *Micarea lignaria* var. *lignaria* and *M. peliocarpa.*

cher siliceux moussu dans une forêt de feuillus, 699.3/122.8, alt. 1150 m, sur bryophytes, 24 août 1998, Vust (G); **Valais**: Salvan, rocaille siliceuse dans une pinède mésophile, 568.3/108.45, alt. 970 m, sur bryophytes et terre nue, 12 octobre 1996, Vust (G).

Micarea peliocarpa (Anzi) Coppins & R.Sant.

This species was identified due to the variable colour of its apothecia, from pale grey to dark black (Fig. 9a), and its C+ red hymenium in section. It was distinguished from *Micarea lignaria* by its lack of green coloration in the hypothecium and its shorter, narrower, one- to five-septate ascospores.
This species is widely distributed throughout Europe, and is a temperate, boreal-montane species found growing in a broad range of ecological conditions (NIMIS & MARTELLOS 2004). In the British Isles it grows mostly below 500 m, whereas in Central and Eastern Europe it is found mainly in mountainous districts (COPPINS 1983). In Switzerland it has been recorded growing at altitudes from the colline to the subalpine vegetation belts of the Swiss Plateau, and the eastern and Southern Swiss Alps (CLERC 2004). *Micarea peliocarpa* is known to grow on a variety of substrata and is "often common on peaty soil, and on moribund bryophytes or peaty debris on old walls, boulders and rock faces, preferring rather more sheltered conditions than *M. lignaria*, with which it is easily confused in the field" (COPPINS 1983).
The unique terricolous specimen identified for this paper was found in the canton of Graubünden (Fig. 17), in the Southern Swiss Alps; however, the species is frequent in Switzerland and is predominantly found growing epiphytically (STOFER et al. 2003). It is for this reason that *M. peliocarpa* was included in the Swiss Red List of Epiphytic Lichen species where it was rated LC, meaning that it is not threatened in Switzerland (SCHEIDEGGER et al. 2002).

Specimen studied: Graubünden: Grono, rocaille siliceuse dans un milieu rocheux anthropogène, 732.85/123.2, alt. 325 m, sur bryophytes et débris de plantes, 20 juillet 1996, Vust (G).

Mycobilimbia carneoalbida (Müll.Arg.) S.Ekman & Printzen (Syn.: *Biatora carneoalbida* [Müll.Arg.] Coppins, *Bacidia carneoalbida* [Müll.Arg.] Coppins)

This species was distinguished from *M. tetramera* based on the paler apothecial pigment in section and the shorter ascospores (COPPPINS 1992b, EKMAN 2004). A tendency was noticed for the apothecia to grow in groups, forming fruiting bodies somewhat resembling bunches of grapes (Fig. 9b).

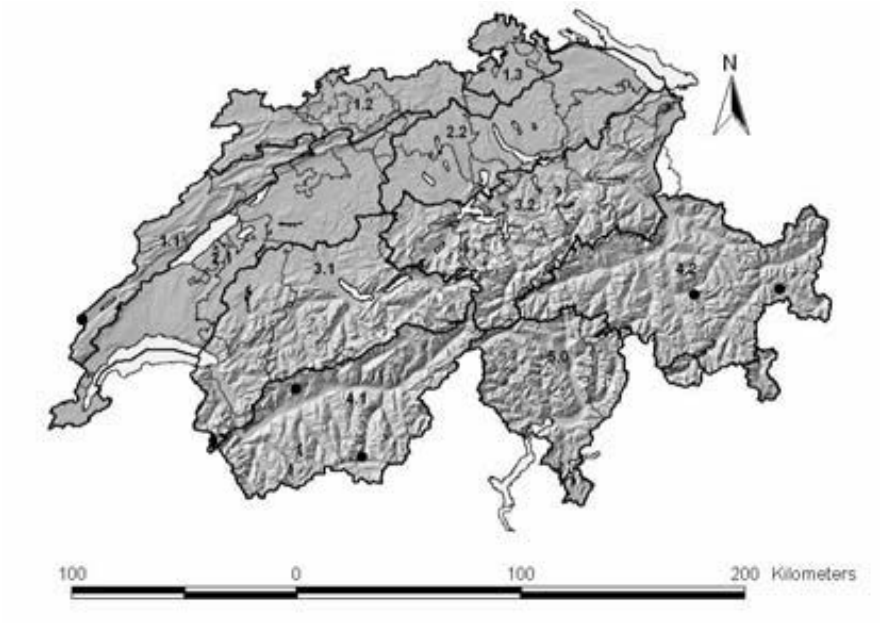

Fig. 18: Known Swiss terricolous distribution of *Mycobilimbia carneoalbida*.

Mycobilimbia carneoalbida is a species whose distribution spreads from Scandinavia throughout the mountains of Central and Southern Europe and North America (COPPINS 1992b). In Switzerland (Fig. 18) it has been recorded in the montane and subalpine vegetation belts ranging from the Eastern Plateau to the Northern and Central Swiss Alps (CLERC 2004) and has been found once growing epiphytically (STOFER et al. 2003).

This species has a varied ecology that ranges from corticolous to terricolous habitats. It is found growing as an epiphytic and terricolous species; in most cases the lichen grows over bryophytes (CLERC 2004, COPPINS 1992b). In the British Isles its unique locality was "on mosses on rock in gully" (COPPINS 1992b). This may indicate a preference for or dependence on the muscicolous habitat that is more important for this species than the substrate upon which the moss grows.

The possibility of this species to inhabit different types of substrates reduces its vulnerability to habitat destruction; however, it is considered threatened in Germany (Table 2).

This species was taken into consideration in the Red List of epiphytic lichen species, where it was classified as vulnerable (VU) (SCHEIDEGGER et al. 2002). When the terricolous specimen data are taken into account the species is classified as LC, due to the fact that the habitats where it grows are not threatened.

Selected specimens studied: Graubünden: Filisur, talus de voie linéaire dans une pessière, 773.526/170.601, alt. 1600 m, sur bryophytes et débris de plantes, 24 mai 1998, Vust (G); **Valais**: Dorbon, tas de cailloux en lisière dans une pessière, 595.475/127.725, alt. 1620 m, sur débris de plantes et autres lichens, 3 août 1996, Vust (G); Zermatt, talus de voie linéaire dans une forêt de mélèzes et d'arolles, 625.301/97.151, alt. 1950 m, sur bryophytes, débris de plantes et terre nue, 24 july 1998, Vust (G); **Vaud**: Risoux, rochers calcaires moussus dans une hêtraie à sapins, 500.25/158.225, alt. 1240 m, sur bryophytes, 20 octobre 1996, Vust (G).

Mycobilimbia tetramera (De Not.) Hafellner & Türk (Syn.: *Biatora tetramera* [De Not.] Coppins, *Mycobilimbia fusca* [A.Massal.] Hafellner & V.Wirth)

Diagnostic for this species are the consistent presence of a thickened true exciple, the flattened shape of the apothecia (Fig. 9c), and the size of the predominantly three-septate ascospores. Specimens were

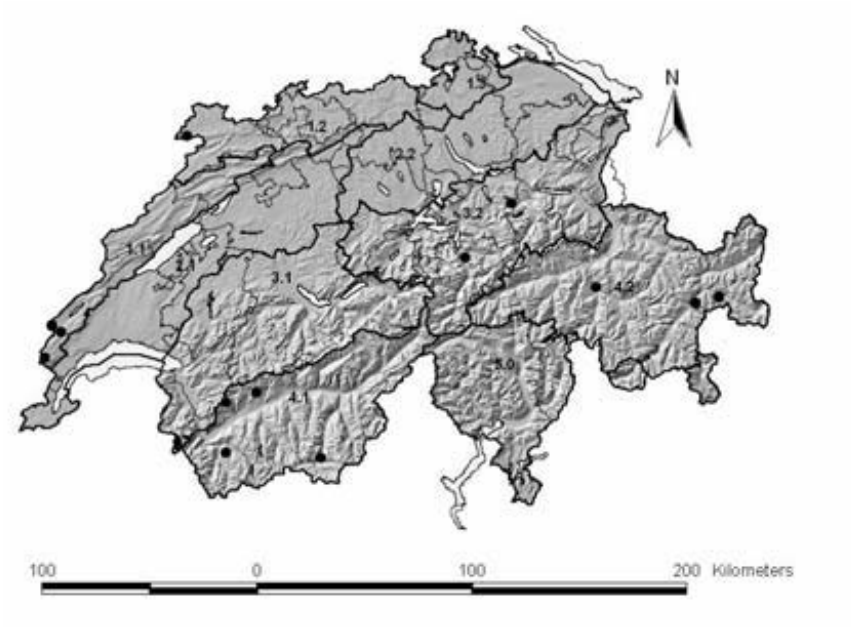

Fig. 19: Known Swiss distribution of *Mycobilimbia tetramera.*

distinguished from *Mycobilimbia carneoalbida* due to darker apothecial pigmentation and longer ascospores, and from *Bilimbia microcarpa* due to the dominant reddish-brown apothecial pigment, the more flattened, wider apothecial morphology, and the lack of ascospore ornamentation.

Mycobilimbia tetramera is documented from Great Britain, Scandinavia, the mountain ranges of Central and Southern Europe and North America (COPPINS 1992b). In Switzerland it has been recorded historically growing at altitudes ranging from the montane to the alpine vegetation belts in all of the biogeographical regions where it is a common terricolous species (CLERC 2004).

Mycobilimbia tetramera occurs on bryophytes, plant debris, shrubs and on or among rocks in alpine situations with altitudes above 1000 meters (COPPINS 1992b). It is new for the cantons of Jura, Schwyz and Uri, but is absent from the Plateau (Fig. 19). The greatest number of specimens was collected in the mountainous regions of Switzerland. This is consistent with the known ecology (COPPINS 1992b). It is reported as present and non-threatened in various European countries including Italy, yet is reported as threatened in Germany (Table 2). This species is classified as LC in Switzerland due to its abundant distribution and its varied ecology.

Selected specimens studied: Graubünden: Fürstenau, graviers calcaires fins dans une pinède subcontinentale basophile, 753.401/175.851, alt. 660 m, sur bryophytes, 22 mai 1998, Vust (G); Cinuos-chel, sol moussu dans une forêt de mélèzes et d'arolles, 799.4/168.85, alt. 2000 m, sur bryophytes et terre nue, 19 juin 1997, Vust (G); **Jura**; Roche d'Or, affleurements moussus dans un pâturage, 563.125/246.275, alt. 815 m, sur bryophytes, 30 juin 1998, Vust (G); **Schwyz**: Wägital, paroi calcaire ombragée, 713.775/215.05, alt. 1200 m, sur bryophytes, 9 juin 1996, Vust (G); **Uri**: Schattdorf, rocaille calcaire dans une forêt de feuillus, 692.55/189.8, alt. 650 m, sur bryophytes, 12 mai 1998, Vust (G); **Valais**: Derbon, tas de cailloux en lisière d'une pessière, 595.475/127.725, alt. 1620 m, sur bryophytes, 3 août 1996, Vust (G); Derborence, rocher calcaire moussu dans une lande méso-hygrophile sur sol acide, 581.15/122.825, alt. 1910 m, sur bryophytes et terre nue, 16 juillet 1997, Vust (G); Zermatt, talus de voie linéaire dans une forêt de mélèzes et d'arolles, 625.301/97.151, alt. 1950 m, sur bryophytes, 24 juillet 1998, Vust (G); **Vaud**: La Dôle, piste de ski rocailleuse calcaire dans un pâturage, 497.2/143.6, alt. 1465m, sur bryophytes, 21 octobre 1996, Vust (G); Risoux, rocaille dans une hêtraie à sapins, 500.525/158.9, alt. 1210 m, sur débris de plantes, 20 octobre 1996, Vust (G).

Table 1: Swiss distribution of considered species, according to cantonal boundaries and natural regions.

Species name	Number of specimens	Cantonal distribution	Natural regions
Bacidia bagliettoana	23 + 1 = 24	BA, BE, GE, **GR**, **JU***, LU, **NE***, **OW***, UR, UW, VD, **VS**, ZH	**1.1**, **1.2**, 2.2, **3.1**, **3.2***, **4.1**, **4.2**
Biatora subduplex	4 + 1 = 5	**BE**, **GR**, TI, **VS**,VD, ZG	1.1, 2.2, **3.1**, **4.1**, **4.2**, 5
Bilimbia lobulata	38 + 2 = 40	**BE**, **FR***, **GR**, LU, **NE**, **TI***, **VD**, **VS**	**1.1**, **3.1**, **3.2**, **4.1**, **4.2**, **5***
Bilimbia microcarpa	5 + 0 = 5	**GR**, LU, **NE***, SO, **UR***, UW, **VD***, ZH	**1.1***, 1.2, 2.2, **3.2**, **4.2**
Bilimbia sabuletorum	30 + 1 = 31	AG, **BA**, **BE**, **GR**, **JU**, LU, **NE***, **OW***, **SG***, **SO**, SZ, UW, **VD**, **VS**, ZH	**1.1**, **1.2**, 2.1, 2.2, **3.1**, **3.2**, **4.1**,**4.2**
Buellia hypophana	3 + 0 = 3	**VS**	**4.1**
Buellia papillata	5 + 2 = 7	**GR**, **VS**	**4.1**, **4.2**
Buellia punctata	4 + 2 = 6	AG, BA, FR, GE, **GR**, LU, SG, SZ, TG, **TI**, **VS**, VD, ZG, ZH	1.1, 1.2, 1.3, 2.1, 2.2, 3.1, 3.2, **4.1**, **4.2**, **5**
Diplotomma geophilum	1 + 0 = 1	**FR***, GR, VD, VS, ZG	1.1, **3.1***, 3.2, 4.1, 4.2
Helocarpon crassipes	1 + 0 = 1	**GR**	**4.2, 5***
"*Lecidea*" *berengeriana*	11 + 13 = 24	BA, BE, **GR**, LU, **TI***, UW, **VS***, **VD**	**1.1**, 1.2, **3.1**, 3.2, **4.1***, **4.2**, **5***
"*Lecidea*" *hypnorum*	16 + 12 = 28	BA, BE, GE, **GR**, LU, TI, UR, UW, **VS**, **VD**	**1.1**, **1.2**, **2.1**, **3.1**, **3.2**, **4.1**, **4.2,** 5
"*Lecidea*" *rufofusca*	3 + 0 = 3	GR, UR, **VS**	3.2, **4.1**, 4.2
Lecidella wulfenii	7 + 0 = 7	BE, GR, SZ, **TI***, UR, **VS**, **VD**	**1.1***, 3.1, 3.2, **4.1**, 4.2, **5***
Lopadium pezizoideum	4 + 1 = 5	BE, **GR**, TI, UR, UW, **VS**, VD	1.1, 3.1, 3.2, **4.1**, **4.2**, **5***
Micarea lignaria var. *lignaria*	7 + 0 = 7	BE, GE, **GR***, **TI***, UW, **VS**, VD, ZH	1.1, 2.1, 2.2, 3.1, 3.2, **4.1**, **5***
Micarea peliocarpa	1 + 0 = 1	BE, GR, LU, SG, SZ, **TI**, UW, ZG, ZH	2.1, 2.2, 3.2, 4.2, **5**
Mycobilimbia carneoalbida	5 + 2 = 7	BE, **GR**, UR, **VS**, **VD**, ZH	**1.1***, 2.2, 3.1, 3.2, **4.1**, **4.2**
Mycobilimbia tetramera	15 + 3 = 18	BA, BE, **GR**, **JU***, SO, **SZ***, TI, **UR***, UW, **VS**, **VD**, ZH	**1.1**, **1.2**, 2.1, 2.2, 3.1, **3.2**, **4.1**, **4.2**, 5
Protomicarea limosa	5 + 0 = 5	BE, **GR**, UR, **VS**	3.1, 3.2, **4.1**, **4.2**, **5***

Cantonal abbreviations correspond to CLERC (2004). Number of specimens: (specimens identified here) + (specimens identified by VUST 2002) = total number of specimens for each species. Cantons or natural regions in normal type represent historical and/or literature records of the species according to CLERC (2004). Cantons or natural regions in bold type represent recent localities, including the specimens examined here as well as those studied by VUST (2002). Cantons or natural regions with an asterisk (*) indicate that the specimen(s) is (are) mentioned for the first time in the canton or in the natural region.

Table 2: Summary of selected species' Red List status in Switzerland and Europe.

			Status in other European countries							
Species name	Red List status	Reasons	A	D	SF	GB	I	NL	S	SK
Bacidia bagliettoana	VU	A, HT	n	T	n	n	n	T	n	n
Bacidia herbarum	EN	60+	T	T	n	n	n	a	n	n
Bacidia illudens	RE	60-	T	a	n	a	a	a	n	n
Biatora subduplex	LC	A, B, E	d	d	d	d	d	d	d	d
Bilimbia lobulata	LC	AB	n	n	n	n	n	†	n	n
Bilimbia microcarpa	LC	AB	n	n	n	a	n	a	n	n
Bilimbia sabuletorum	LC	A, B, E	d	d	d	d	d	d	d	d
Buellia hypophana	EN	HT	d	T	a	a	a	a	a	a
Buellia papillata	LC	A	n	n	a	a	n	a	n	T
Buellia punctata	LC	A, B, E	d	d	d	d	d	d	d	d
Diplotomma geophilum	NT	B	n	n	n	a	R	a	n	n
Helocarpon crassipes	LC	A	a	a	a	T	a	a	a	T
"*Lecidea*" *berengeriana*	LC	A, B	n	n	n	n	n	a	n	T
"*Lecidea*" *hypnorum*	LC	A, B	n	d	n	a	n	a	n	T
"*Lecidea*" *rufofusca*	LC	A, B	d	d	d	d	d	d	d	d
"*Lecidella*" *alpestris*	RE	60-	T	a	n	a	n	a	n	a
Lecidella wulfenii	LC	B, 3+	n	n	n	n	n	a	n	n
Lopadium pezizoideum	LC	A, B	n	n	n	n	n	a	n	T
Micarea lignaria var. *lignaria*	LC	A, B, E	d	d	d	d	d	d	d	d
Micarea peliocarpa	LC	A, E	d	T	d	d	d	d	d	d
Mycobilimbia carneoalbida	LC	A, B, E	d	T	d	d	d	d	d	d
Mycobilimbia tetramera	LC	A, B	n	T	n	n	n	a	n	n
Protomicarea limosa	LC	B, 3+	n	d	n	n	n	a	n	T

Red List status: RE – regionally extinct, EN – endangered, VU – vulnerable, NT – near threatened, LC – least concern.

Reasons for Red List status: A – found in A samples, B – found in B samples, HT – habitat threatened, E – considered in the epiphytic lichen Red List, 60+ – found in Switzerland after 1960, 60- – not found after 1960, 3+ – found in more than 3 sites.

European countries and sources: A – Austria (TÜRK & HAFELLNER 1999, HAFELLNER & TÜRK 2001), D – Germany (SCHOLZ 2000, WIRTH et al. 1996), SF – Finland (VITIKAINEN et al. 1997), GB – Great Britain (CHURCH et al. 1996, PURVIS et al. 1994), I – Italy (NIMIS 1993, 2000), NL – The Netherlands (APTROOT et al. 1998), S – Sweden (MATTSSON 1995, SANTESSON et al. 2004), SK – Slovakia (PIŠÚT et al. 1993)

Status in other countries: † – extinct, T – threatened, R – rare, n – present but not threatened or rare, a – absent, d – data not available or incomplete.

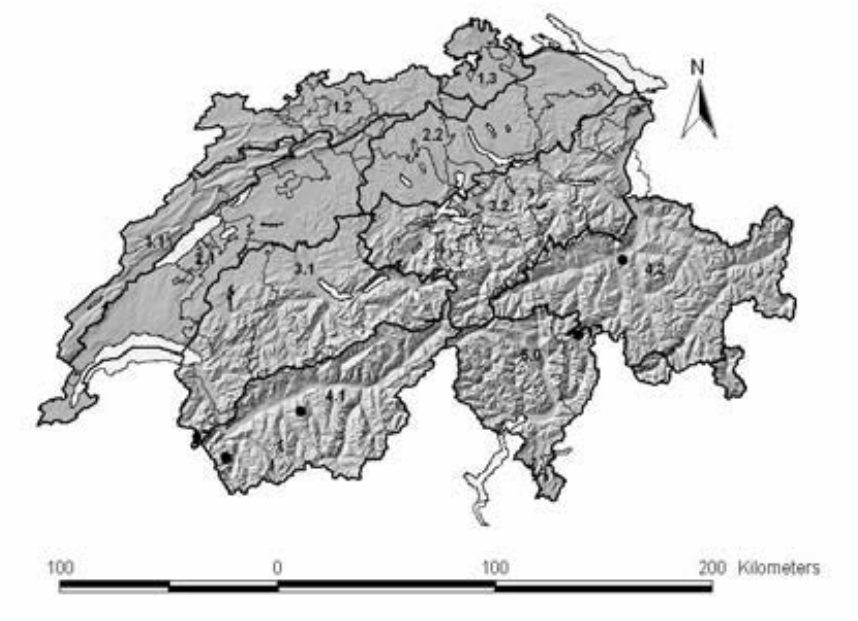

Fig. 20: Known Swiss distribution of *Protomicarea limosa*.

Protomicarea limosa (Ach.) Hafellner (Syn.: *Lecidea limosa* Ach.)

This species was identified due to its Pd+ orange thallus (Fig. 9d) (pannarin), the deep green epihymenium and the short, non-septate ascospores.

Protomicarea limosa is an arctic-alpine to boreal-montane circumpolar lichen (NIMIS & MARTELLOS 2004). In Switzerland it has been documented growing at altitudes from the subalpine to the alpine vegetation belts in the Northern and Central Swiss Alps (CLERC 2004).

This species' habitat preferences include areas characterized by long snow cover, where it is typically collected on bare, more or less siliceous soil, and more rarely over bryophytes or plant debris (CLERC 2004, NIMIS & MARTELLOS 2004). Its distribution is thus restricted to relatively humid areas, rendering it rare even in areas where it is present.

The specimens identified from Vust's collections were mostly collected in acidic snow depressions, confirming this species' known ecology. Its discovery at four locations in non-threatened habitats throughout Switzerland (Fig. 20) indicates that while not a common species, it is not considered threatened and can be classified as LC.

Selected specimens studied: Graubünden: San Bernardino, combe à neige acide, 733.65/150.7, alt. 2090 m, sur débris de plantes et terre nue, 22 juillet 1996, Vust (G); Feldis, butte dans une lande méso-hygrophile sur sol acide, 754.4/185.5, alt. 1900 m, sur terre nue, 5 juin 1999, Vust (G); **Valais**: Combe d'Orny; combe à neige acide, 572.25/94.8, 23 août 1996, alt. 2470 m, sur terre nue, Vust (G); Vallon de Réchy, au-dessus de Tsalet, butte dans une combe à neige calcaire, 606.5/116.1, alt. 2450 m, sur bryophytes et terre nue, 14 août 1996, Vust (G).

Discussion

Of the 20 species considered in this study, 17 are boreal-montane to arctic alpine species and most of them are strictly terricolous. The term "terricolous" as it is defined in the introduction comprises lichens growing on bryophytes growing on bare soil, rocks, or other substrata, as

well as on plant debris close to the level of the soil. These habitats are rich in lichen species because they provide growing conditions too harsh for most vascular plant species. It is thus that many rare lichen species find their niche in these hostile settings. These species have a capacity to grow under extreme conditions, exposed to low average temperatures, short growing seasons, high wind velocities, or frequent disturbance due to substratum movement. This capacity to resist harsh conditions combined with the slow growth rate characteristic of crustaceous lichen species define the ecological niche of most of the species considered here. Most of these species are growing on mosses. Fixation to mosses and/or plant debris is one solution providing the stability necessary for slow-growing organisms such as crustaceous terricolous lichens. The combination of relatively harsh conditions reinforces the role of mosses and plant debris in creating micro-climates acceptable for many lichen species. The typical extreme "terricolous-muscicolous" habitat is an exposed high-altitude locality, subject to cool average temperatures that slow the degradation of organic material, and high wind velocities. Moribund bryophytes and plant remains are ± well-fixed to the soil or rocks upon which they grow, providing some stability. In addition to this substrate function, it is possible that bryophytes act as humidity buffers. For some species, the muscicolous ecology seems to be of prime importance, and the substrate of the bryophyte is secondary: *Bacidia bagliettoana*, *Bilimbia sabuletorum*, *Micarea lignaria* and *Mycobilimbia carneoalbida*.

Our study allows an evaluation of the Red List status of 10 species previously classifed as DD in the Swiss Terricolous Lichens Red List (CLERC & VUST 2002). The remaining 10 species considered in this study were previously classified in either the terricolous or epiphytic Red List: 7 were classified as LC, 1 as VU, and the remaining 2 were not considered (Table 2). All but three of the species considered in this study can be classified as LC for various reasons (see Table 2). The three remaining species have three different classifications: *Bacidia bagliettoana* (VU), *Buellia hypophana* (EN), and *Diplotomma geophilum* (NT).

The results of VUST (2002) and this study show (Table 1) that many species were not found in the cantons and/or natural regions in which they have been historically reported (CLERC 2004). It would be erroneous to conclude that these species are experiencing regressions because the stratified sampling plan was based on vegetation types rather than political boundaries. This implies that for cantons or natural regions whose vegetation type diversity is limited, the number of sampling sites is much smaller. Future sampling plans may attempt to avoid this kind of under-representation by augmenting the number of sampling sites and using a second criterion, such as political boundaries (cantons) or a number of sites per unit area to complement the site choice. On the other hand, if the researched species are difficult to observe in the field, increasing sampling efforts would not necessarily increase results.

Five species have not been found among the specimens, despite the fact that their morphologies correspond to the initial sorting criteria (see Materials and Methods). Two of these species should be eliminated from the Swiss Red List, because the documented localities are old (c. 1890) (CLERC 2004) and have never been confirmed by a specialist: "*Lecidea*" *ileiformis* Fr. and "*Lecidea*" *diapensiae* Th.Fr. The remaining three species include *Bacidia herbarum* (Stizenb.) Arnold, *B. illudens* (Nyl.) Lynge, and *Lecidella alpestris*. Neither *Bacidia illudens* nor *Lecidella alpestris* have been documented in Switzerland since the 1960's (CLERC 2004). The lack of recent collections allows us to attribute the category RE (regionally extinct) to these two species. The last species to be considered, *Bacidia herbarum*, has been found once since 1960 (VAN DEN BOOM & CLERC 2000) and should be considered endangered (EN).

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