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Sampling multi-scale and multi-taxon plant diversity data in the subalpine and alpine habitats of Switzerland: Report on the 14th EDGG Field Workshop

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Abstract: The 14th EDGG Field Workshop took place from the 4th to the 14th of September 2020 in Switzerland, and was devoted to the vegetation of open habitats in the subalpine and alpine zones. In total, 26 EDGG Biodiversity Plots (nested plots with grain sizes of 0.0001 to 100 m²) were sampled in different open habitat types (grasslands, heathlands, screes, snowbeds, fens) in three regions of Switzerland, both over acidic and base-rich bedrock. Additionally, three normal plots of 10 m² were sampled in high-elevation *Festuco-Brometea* stands in Zermatt. Across all grain sizes, stands showed 10–25% higher means and 50–94% higher maxima for total richness of vascular plants, terricolous bryophytes and lichens compared with data from the 12th EDGG Field Workshop in dry and semi-dry grasslands of the central valleys of the Swiss Alps. We found outstanding preliminary maxima of total richness of 61, 109 and 163 species in 1, 10 and 100 m² respectively, in an unused alpine grassland over limestone (*Seslerion*). Both particularly variable and partly extremely rich was the bryophyte and lichen flora of the analysed stands, with up to 33 bryophyte and 22 lichen species in 10-m² plots. We report the liverwort *Cephaloziella dentata* as new for Switzerland, found in a thermophilous subalpine heathland at Alp Glivers, Surselva, Grisons. Overall, our preliminary data suggest that some of the sampled subalpine and alpine habitats are among the most species-rich communities at small scales if bryophytes and lichens are also considered. Based on this finding, we recommend that these two taxonomic groups be more regularly included in surveying and particularly in monitoring programs for vegetation. The Scientific Report is supplemented by a photo diary that provides impressions of work and life during the Field Workshop.

Keywords: alpine grassland; biodiversity; bryophyte; *Cephaloziella dentata*; dwarf shrub heath; elevational gradient; Eurasian Dry Grassland Group (EDGG); fen; *Festuco-Brometea*; lichen; nested plot; scree; *Seslerion*; snow bed; soil pH; species richness; Switzerland; vascular plant.

Nomenclature: Juillerat et al. (2017) for vascular plants; Meier et al. (2013) for bryophytes; Nimis et al. (2018) for lichens; Mucina et al. (2016) for syntaxa.

Abbreviation: EDGG = Eurasian Dry Grassland Group.

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Introduction

Field Workshops (formerly called Research Expeditions) are a major element of the annual activities of the Eurasian Dry Grassland Group (EDGG) (see Vrahnakis et al. 2013). In May 2020, the planned 14th Field Workshop in Ukraine (Vynokurov et al. 2019) had to be cancelled and postponed to 2021 due to the Corona pandemic. This prompted some of the regular participants of EDGG Field Workshops to organise an ad-hoc event in late summer, when the infection rates throughout Europe were relatively low and people from several countries could travel. We chose the subalpine and alpine open habitats of Switzerland as the target for two reasons: (1) these habitats can still be sampled quite well in September, as they contain only a very small fraction of therophytes and geophytes (see Baumann et al. 2016) and (2) while dry grasslands at lower elevations are very well represented in the GrassPlot database (Dengler et al. 2018; Biurrun et al. 2019), alpine grasslands and particularly non-grassland habitats of the subalpine and alpine zones, such as dwarf-shrub heaths, snow beds, screes and moraines, as well as fens, are largely underrepresented. This means that we lack knowledge on scale-dependent biodiversity patterns in these habitats, particularly when it comes to bryophytes and lichens, which are known to play a much bigger role within these habitats than in the lowlands.

EDGG has decided to call this ad-hoc event the 14th EDGG Field Workshop as we used the standardised EDGG methodology (Dengler et al. 2016) and will contribute the data to the EDGG-affiliated GrassPlot database (Dengler et al. 2018; Biurrun et al. 2019; https://edgg.org/databases/GrassPlot) for overarching studies. In this contribution, we report on the 14th Field Workshop (including a photo diary in the Appendix) and provide some preliminary results.

The 14th EDGG Field Workshop

The Field Workshop was attended by nine people from four countries (Switzerland, Germany, Poland and China) (Fig. 1). Since several colleagues participated only partially, there were on average 5.7 people present on each of the 10 sampling days.

We sampled in three different regions (Fig. 2, Table 1) to reflect geological and biogeographical differences: (1) the Glarus Alps (cantons Glarus and Uri) with base-rich bedrock; (2) Surselva (canton Grisons) with acidic bedrock and (3) around Zermatt (canton Valais) with both acidic (Fig. 3) and base-rich bedrock (Fig. 4). In each of the three regions we

Fig. 1. The Field Workshop team on 5 September 2020 above Alp Glivers, Surselva, Switzerland. From left to right standing: Beata Cykowska-Marzencka, Iwona Dembicz, Hallie Seiler, Susanne Riedel, Timon Bruderer, Patrick Neumann and Christian Dolnik; in the front: Jürgen Dengler. Jinghui Zhang is missing in this photo, since he only participated in the last third of the Field Workshop. Photo: J. Dengler.

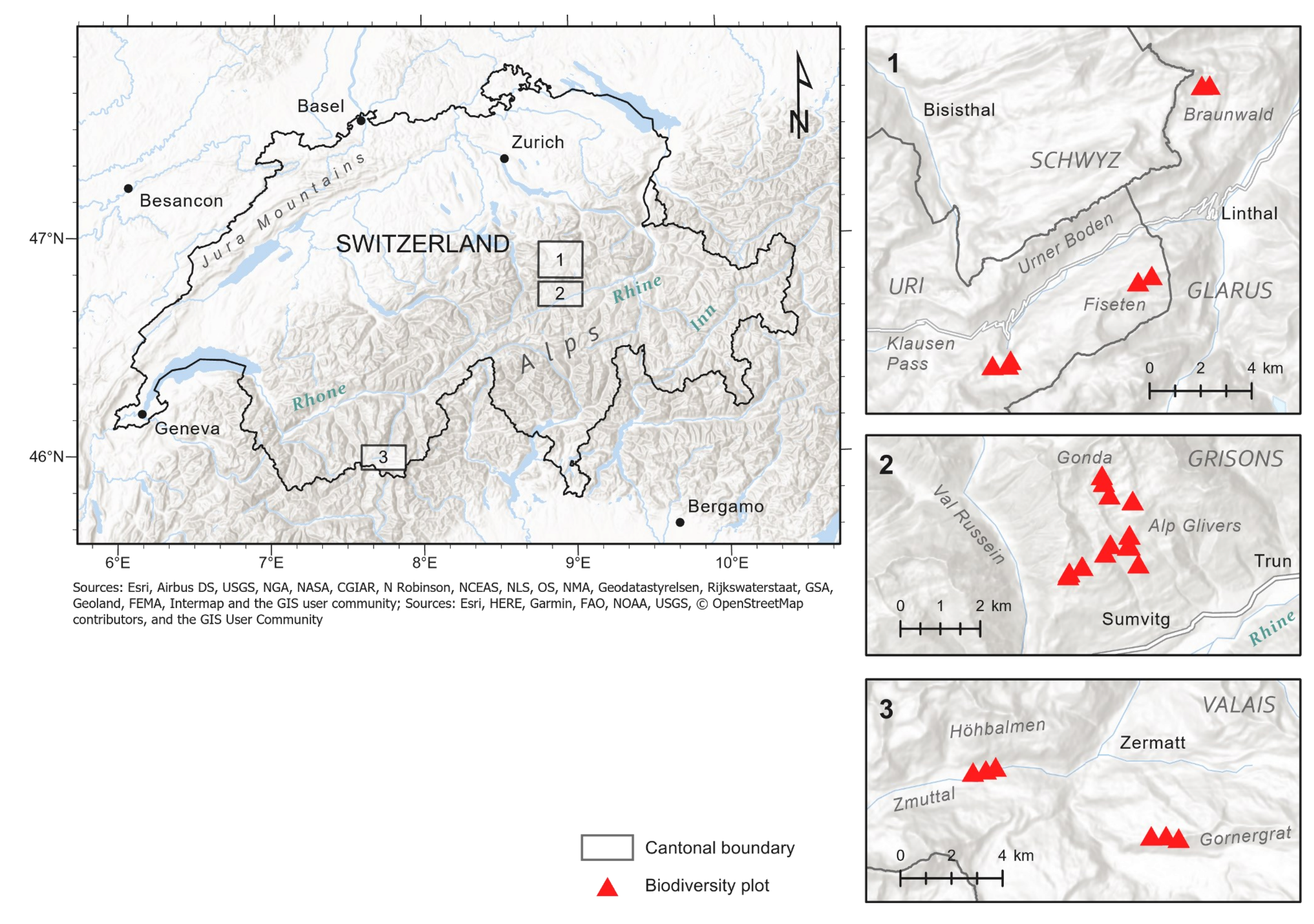

Fig. 2. Distribution of the sampling sites of the 14th EDGG Field Workshop in four cantons of Switzerland (Valais, Uri, Glarus and Grisons). Prepared by H. Seiler.

tried to cover the diversity of open habitat types of the subalpine and alpine zones as far as this was possible within the limited time. This means that we included both natural and secondary habitats, both with current landuse (i.e. livestock grazing) and without. We spread our plots across the main habitat types found at this elevation: grasslands (both livestock-grazed and unused), heathlands (both low and tall), screes, moraines, snowbeds and fens (Table 1; Figs. 3 and 4). Our plots of subalpine and alpine habitats were located at elevations between 1,874 and 3,076 m a.s.l. They ranged from 45.98° to 46.96° northern latitude and from 7.68° to 8.98° eastern longitude. While mean annual temperature varied only from –1.9 to +1.4 °C, the variability in mean annual precipitation was more pronounced, ranging from 613 to 1,908 mm (Fig. 5).

In total, we sampled 26 nested-plot series (“EDGG biodiversity plots”; Fig. 6) with grain sizes of 0.0001–100 m² (Table 1). Additionally, we sampled three 10-m² plots (“normal plots” in EDGG terminology: Dengler et al. 2016) of high-elevation *Festuco-Brometea* communities in Zermatt (Fig. 7) to complement the data of the 12th EDGG Field Workshop (Dengler et al. 2020). Our plots are permanently marked with soil magnets to allow future resampling to analyse possible changes of the vegetation due to global change.

Initial results and discussion

Floristic composition and species of special interest

The most frequent vascular plants in the subalpine and alpine habitats of the three regions (based on the 52 10-m² plots) were *Leontodon helveticus* (44%), *Anthoxanthum odoratum* aggr. (38%), *Campanula scheuchzeri* (38%), *Nardus stricta* (37%) and *Vaccinium myrtillus* (33%). Among the bryophytes, *Racomitrium canescens* aggr. (33%), *Pleurozium schreberi* (31%), *Polytrichum juniperinum* (25%) and *Weissia* spp. (25%) were most widespread. Finally, among the lichens, *Cetraria islandica* (29%), *Cladonia arbuscula* (19%) and *Cladonia macroceras* (17%) reached the highest constancy. In all of these cases, such high constancies indicate that species have low affinity to specific vegetation types and often occur over both siliceous and limestone bedrock.

In one plot, we found the foliose liverwort *Cephaloziella dentata* (Raddi) Mig., which is the first record for Switzerland (i.e. the species is not included in Meier et al. 2013).

Table 1. Overview of the sites studied during the 14th EDGG Field Workshop 2020.

Plot	Date	Canton	Municipality	Location	Bedrock	Vegetation type
CHA01	4.09.20	Grisons	Sumvitg	Alp Glivers	acidic	Grassland (grazed)
CHA02	4.09.20	Grisons	Sumvitg	Alp Glivers	acidic	Heathland (tall)
CHA03	5.09.20	Grisons	Sumvitg	Gonda	acidic	Scree
CHA04	5.09.20	Grisons	Sumvitg	Gonda	acidic	Grassland (unused)
CHA05	5.09.20	Grisons	Sumvitg	Gonda	acidic	Snowbed
CHA06	5.09.20	Grisons	Sumvitg	Alp Glivers	acidic	Heathland (low)
CHA07	6.09.20	Grisons	Sumvitg	Alp Glivers	acidic	Heathland (tall)
CHA08	6.09.20	Grisons	Sumvitg	Alp Glivers	acidic	Fen
CHA09	7.09.20	Grisons	Sumvitg	Alp Crap Ner	acidic	Heathland (tall)
CHA10	7.09.20	Grisons	Sumvitg	Alp Crap Ner	acidic	Snowbed
CHA11	7.09.20	Grisons	Sumvitg	Alp Crap Ner	acidic	Heathland (low)
CHA12	7.09.20	Grisons	Sumvitg	Alp Crap Ner	acidic	Heathland (tall)
CHA13	7.09.20	Grisons	Sumvitg	Alp Glivers	acidic	Grassland (grazed)
CHA14	9.09.20	Valais	Zermatt	Zmutttal	base-rich	Moraine
CHA15	9.09.20	Valais	Zermatt	Zmutttal	base-rich	Scree
CHA16	9.09.20	Valais	Zermatt	Zmutttal	base-rich	Grassland (unused)
CHA17	10.09.20	Valais	Zermatt	Gornergrat	acidic	Scree
CHA18	10.09.20	Valais	Zermatt	Gornergrat	acidic	Snowbed
CHA19	10.09.20	Valais	Zermatt	Gornergrat	acidic	Grassland (grazed)
CHA20	12.09.20	Glarus	Braunwald	Gumen	base-rich	Scree
CHA21	12.09.20	Glarus	Braunwald	Gumen	base-rich	Grassland (grazed)
CHA22	13.09.20	Uri	Urnerboden	Im Gries	base-rich	Moraine
CHA23	13.09.20	Uri	Urnerboden	Im Gries	base-rich	Snowbed
CHA24	13.09.20	Uri	Urnerboden	Im Gries	base-rich	Heathland (low)
CHA25	14.09.20	Uri	Urnerboden	Fisetengrat	base-rich	Grassland (unused)
CHA26	14.09.20	Uri	Urnerboden	Fisetengrat	base-rich	Grassland (unused)

The plot was located on *Arctostaphylos uva-ursi* heathland on a steep south-facing slope on Alp Glivers (Plot CHA07; 46.7508° northern latitude, 8.9317° eastern longitude, 2,080 m a.s.l.). According to Paton (1999), this species occurs in southern Great Britain, where it is known only from a few sites in *Erica vagans-Calluna* heathlands of western Cornwall. The species has also been recorded in Mediterranean countries such as Spain, France, Sardinia, Sicily, Italy, former Yugoslavia and Turkey, as well as Denmark, Sweden, and Madeira (Paton 1999; Damsholt 2002; Keçelı & Çetın 2006). As *Cephaloziella* species belong to the smallest hepatics of our flora, they are easily overlooked. Diagnostic features of *C. dentata* are its minutely toothed leaves and the typical tuberculate gemmae on the tips of some leaves.

Phytodiversity

Our phytodiversity data are preliminary, as some critical vascular plants and more bryophytes and lichens have yet to be determined or confirmed in the lab. This should not create a systematic bias in our data for the grain sizes between 0.0001 and 10 m², as something recognised as a different species in the field will likely remain a different species irrespective of the final determination. However, for the 100-m² grain size, our preliminary richness data will likely overestimate the true richness by approx. 5–10%, as the same species might have been collected under a different "field name" in both corners.

We found that mean total species richness (i.e. vascular plants + terricolous bryophytes and lichens) increased from 2.7 species in 0.0001 m² to 22.8 species in 1 m², and again from 38.1 species in 10 m² to 69.2 species in 100 m² (Table 2). Interestingly, these values are between 10% and 25% higher than the means found last year in the dry and semi-dry grasslands of the central valleys of the Swiss Alps (Dengler et al. 2020). However, means only tell part of the story; in the subalpine and alpine vegetation we found much larger variability in richness across all scales than in the xerothermic vegetation in the lower parts of these valleys. Actually, all of our minima for the subalpine and alpine open vegetation (excluding values of 0) were lower, and the maxima were all higher. Particularly striking is the difference in the maxima, which were between 50% and 94% higher than those from the xerothermic grasslands of the same regions. The increase was strongest for grain sizes of 1 m² and larger, with increases of 80% and more (despite having more replicates at lower elevations): 61 vs. 33 species in 1

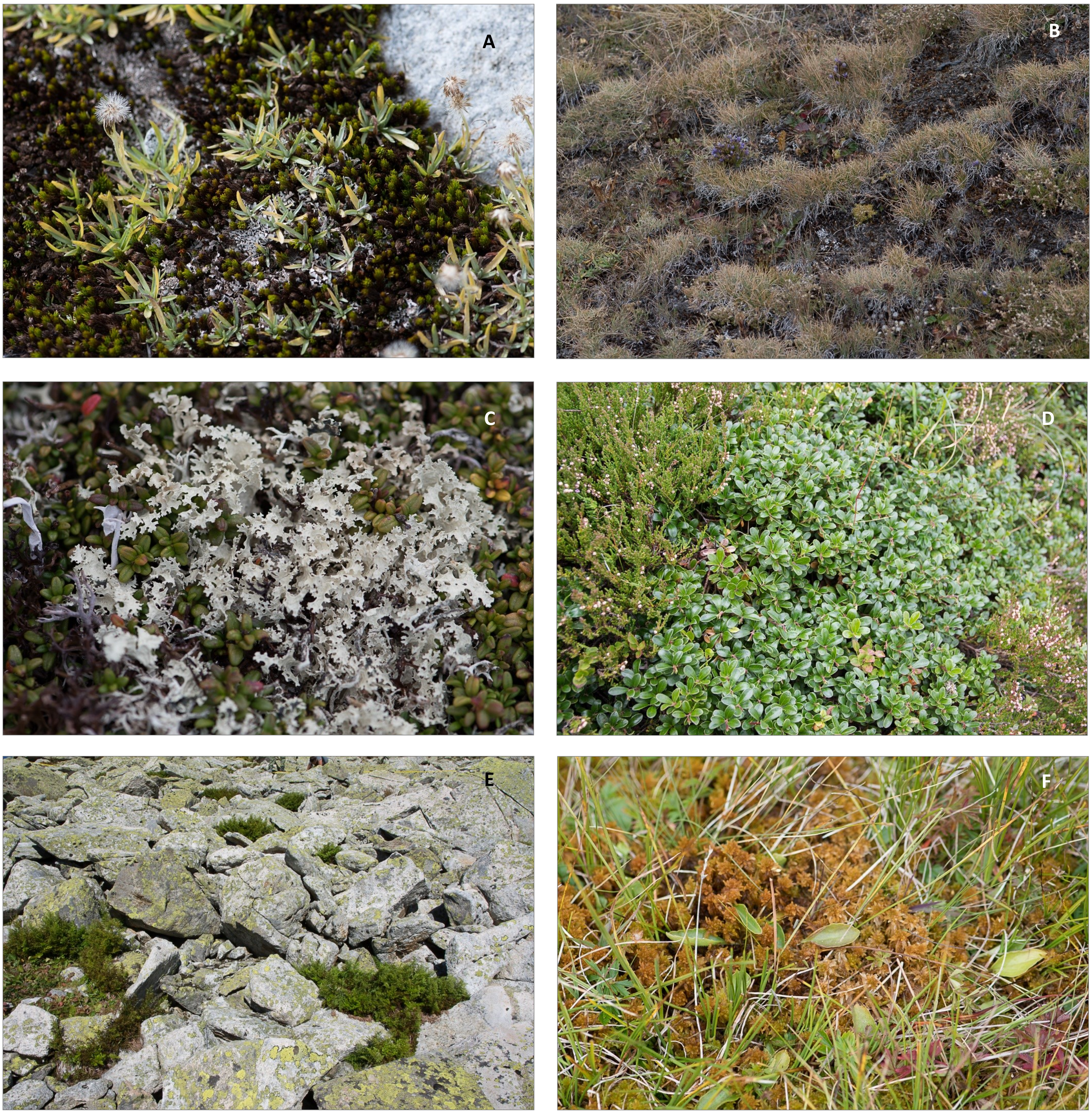

Fig. 3. Examples of the main vegetation types studied over acidic bedrock: (a) snowbed vegetation with *Gnaphalium supinum* and *Polytrichastrum sexangulare*; (b) alpine grassland with *Festuca halleri* aggr.; (c) low-grown wind-exposed alpine heath with *Loiseleuria procumbens* and *Flavocetraria nivalis*; (d) taller, thermophilous subalpine heath with *Arctostaphylos uva-ursi* and *Calluna vulgaris*; (e) scree with *Cryptogramma crispa*; (f) fen with *Sphagnum inundatum*. Photos: J. Dengler.

Fig. 4. Examples of the main vegetation types studied over limestone. (a) snowbed vegetation with *Salix retusa*; (b) vegetation on a recent moraine with *Adenostyles alpina* and *Saxifraga aizoides*; (c) alpine grassland with *Sesleria varia* and *Scaciosa lucida*; (d) dwarf-shrub heath with *Dryas octopetala*. Photos: J. Dengler.

m², 109 vs. 60 species in 10 m² and 163 vs. 84 species in 100 m². Currently, the highest values in the GrassPlot database (version 2.09 as of 4 October 2020; see Dengler et al. 2018; Biurrun et al. 2019) are 159 for a mesoxeric grassland in Armenia (Aleksanyan et al. 2020), 146 for a mesoxeric grassland in the White Carpathians, Czech Republic, and 134 and 129 species for mesoxeric grasslands in the Transylvanian Plateau, Romania. However, as the final species determination has not yet been completed for the Armenian dataset, its species richness will likely be slightly lower than initially reported. So, there is a good chance that our plot will become the new Palaearctic record holder, presumably with 150–155 species after determination and correction. Interestingly, all the hitherto top-ranked plots for total species richness in 100 m² (the named ones and some more) belong to the order *Brachypodietalia pinnati* (class *Festuco-Brometea*), while our stand is from the alliance *Seslerion caeruleae* (class *Elyno-Seslerietea*). While this plot could likewise be considered a mesoxeric, basiphilous grassland, it is also a natural grassland above the timberline and at least currently ungrazed, unlike the other top-ranked plots, all of them secondary, semi-natural grasslands.

While our total richness values are outstanding, at least for the more diverse habitats, those for vascular plants are high, but not exceptional, when compared to other grassland types. For bryophytes and lichens, the story is different. Bryophyte and lichen richness varied widely; in 10 m², for example, we found between 0 and 33 bryophyte species and between 0 and 22 lichen species (Table 2). Also, the contribution of non-vascular species to total richness varied from 0% to 73% at 10 m². This means that in some subalpine and alpine habitats cryptogams were virtually absent, while in others they outnumbered the vascular plant species three-fold. On average, there were 8.5 bryophyte species and 4.0 lichen species in 10 m², accounting for 32% of the total richness.

Considering the main habitat and bedrock types, we found pronounced differences in species richness (Fig. 8). The species richness of the complete vegetation (all three taxonomic groups together) and of vascular plants alone was hig-

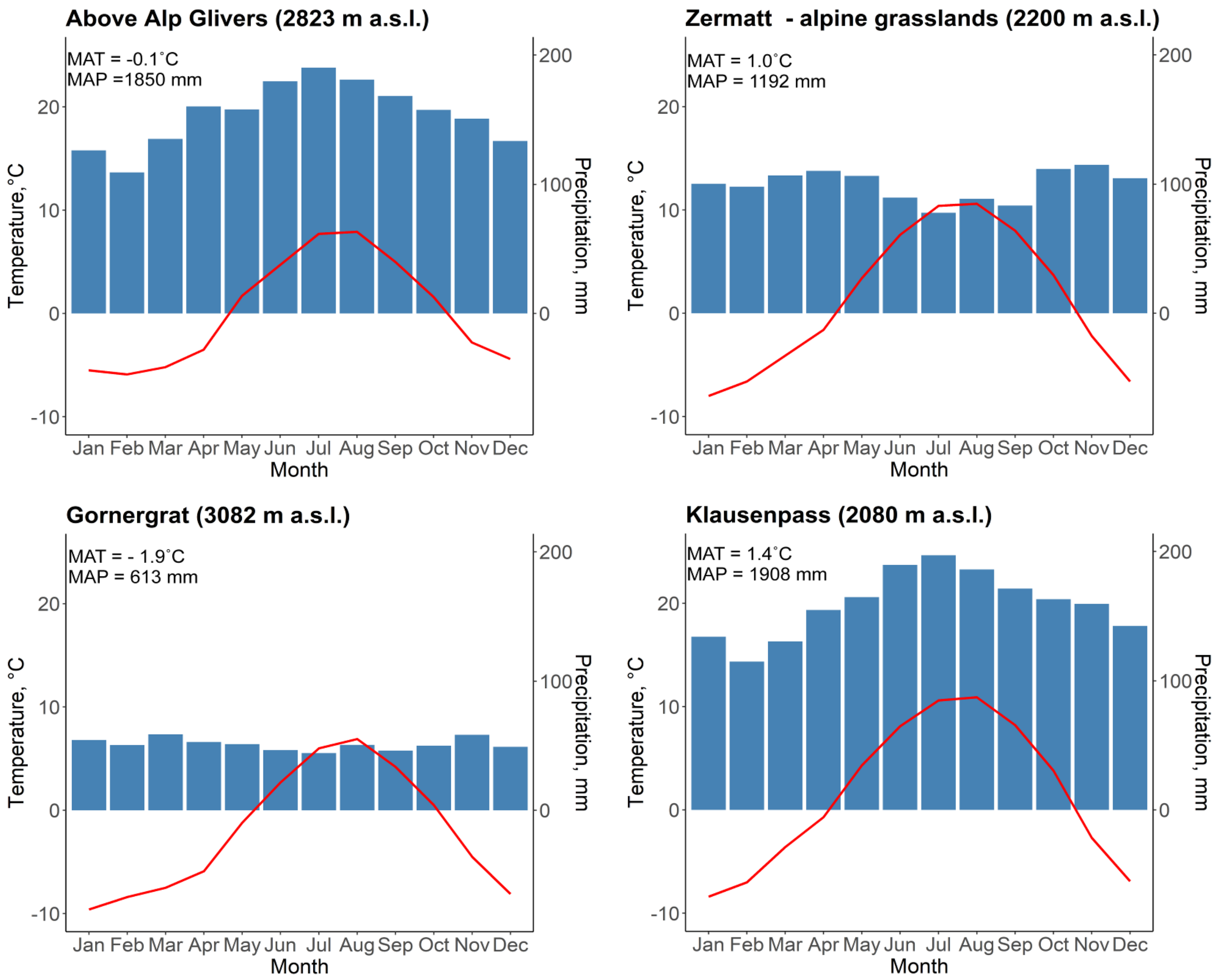

Fig. 5. Climate diagrams for the grid cells of the plots CHA06 (46.76070° N; 8.93314° E), CHA14 (46.00683° N; 7.67753° E), CHA17 (45.98319° N; 7.78136° E), CHA23 (46.85907° N; 8.87445° E) representing four main sampling areas: vicinities of Alp Glivers, vicinities of Zermatt, Gornergrat and Klausenpass, respectively. Data were obtained from CHELSA (Karger et al. 2017) in 30 sec resolution via QGIS (QGIS Development Team 2019) and processed with the R package *ggplot2* (Wickham 2016). MAT – mean annual temperature, MAP – mean annual precipitation.

Table 2. Preliminary species richness data from the 14th EDGG Field Workshop in Switzerland. For the grain sizes from 0.0001 to 10 m² the richness values should be more or less unbiased, but for 100 m² the values are likely about 5–10% too high, as the same species might have been noted under different "field names" in the two opposite corners.

		Total richness		Vascular plants		Bryophytes		Lichens	
Area [m²]	*n*	Mean	Range	Mean	Range	Mean	Range	Mean	Range
0.0001	52	2.7	0–8	1.9	0–5	0.6	0–5	0.3	0–4
0.001	52	4.5	0–14	3.1	0–8	1.0	0–8	0.3	0–6
0.01	52	7.6	0–22	5.4	0–13	1.6	0–8	0.6	0–8
0.1	52	13.4	1–36	9.5	1–23	2.8	0–11	1.2	0–12
1	52	22.8	4–61	16.0	4–44	4.9	0–16	1.9	0–13
10	52	38.1	4–109	25.5	4–66	8.5	0–33	4.0	0–22
100	26	69.2	27–163	44.4	16–103	16.3	2–45	8.5	0–31

Fig. 6. Sampling of the EDGG biodiversity CHA01 (upper photo) in a subalpine *Nardus stricta* grassland on Alp Glivers, Grisons, with approx. 100 species in 100 m² and of EDGG biodiversity plot CHA25 (lower photo) in an alpine *Sesleria caerulea* grassland at Fissetengrat, Uri, with approx. 150 species in 100 m². Photos: J. Dengler.

Fig. 7. In the Zmutt valley below the Matterhorn in Zermatt, we sampled three 10-m² normal plots of *Festuco-Brometea* stands at unusually high elevation (around 2000 m a.s.l.), with *Stipa pennata*, *Bromus erectus* and various *Festuca* species. Photo: J. Dengler.

hest in grasslands, and lowest in screes and moraines. Bryophytes did not show large differences in diversity between habitats, except that screes and moraines were the poorest habitats. Most habitats were poor in lichen species, except acidic heathlands and acidic snowbeds.

Interestingly, bedrock type had contrasting effects on the three taxonomic groups. For those four habitat types that were sampled over both acidic and base-rich bedrock, vascular plants and bryophytes had consistently higher median richness in the base-rich subtype, whereas the opposite was the case for lichens (except screes and moraines where lichen richness was equally low irrespective of bedrock chemistry) (Fig. 8). Taking all three taxonomic groups together still resulted in higher richness of base-rich vs. acidic subtypes in the case of grasslands, screes and moraines, whereas total richness values were very similar in the case of heathlands and snowbeds. While for lowland habitats in Central and Northern Europe it is a well-known phenomenon that base-rich types are more species-rich in vascular plants than their acidic counterparts (Ewald 2003; Schuster & Diekmann 2003), this has to our knowledge not been systematically shown for subalpine and alpine habitats before, except for mires (Sekulová et al. 2013), where we did not have a paired sampling. For alpine habitats in Switzerland at the 1-m² grain size, Vonlanthen et al. (2006) found a unimodal relationship of vascular plant species richness to soil pH with a peak around pH = 5.5. Thus, in subsequent analyses, we will have to address the reasons for this apparent discrepancy. It could be the different grain size (1 m² instead of 10 m²), pooling all habitat types in one analysis instead of habitat-specific comparisons, using the actual pH of the upper soil horizon vs. the bedrock type or a combination thereof. Additionally, the similar pattern for bryophytes and the largely reversed pattern for lichens have not been generally acknowledged previously. The contrasting behaviour of the three taxonomic groups underlines the necessity to take non-vascular taxa into account when studying biodiversity patterns of vegetation.

Conclusions and outlook

The preliminary data already demonstrate that the vegetation types of open alpine and subalpine areas in the Alps are particularly species rich, with some types even comparable to mesoxeric basiphilous grasslands in terms of total species richness. We also found that richness in these elevational belts seems to be more variable than in the lowlands (i.e. both minima lower and maxima higher), which is probably attributable to higher small- to medium-scale variability in topography and soil conditions. Also striking was the high average contribution of bryophytes and lichens to total richness, which together occasionally outnumbered vascular plant species three-fold. This finding suggests that for proper biodiversity monitoring, at least within these elevational belts, the non-vascular plants should be considered. By contrast, of the three national biodiversity monitoring programs of Switzerland (BDM: Koordinationsstelle, 2014; WBS: Bergamini et al. 2019; ALL-EMA: Riedel et al. 2018), only BDM currently considers bryophytes, and none of them consider lichens.

We plan to finalise the identification of the remaining critical vascular plant, bryophyte and lichen species by the end of the year. Major parameters of the collected soil samples will be analysed concurrently, according to EDGG standards (Dengler et al. 2016). Once these steps are completed, we intend to use our dataset to prepare a study of scale- and taxon dependent patterns and drivers of vegetation diversity in these habitat types. As soon as the vegetation data are ready, they will also be integrated in the GrassPlot database (Dengler et al. 2018; Biurrun et al. 2019) and the emerging Swiss national vegetation database (“Veg.CH”) and via these in the European Vegetation Archive (EVA; Chytrý et al. 2016) and the global plot database “sPlot” (Bruelheide et al. 2019) to allow the best possible use. Moreover, the floristic information will be fed into the database of the National Data and Information Center on the Swiss Flora (“Info Flora”; https://www.infoflora.ch), bryophytes (“Swissbryophytes”;

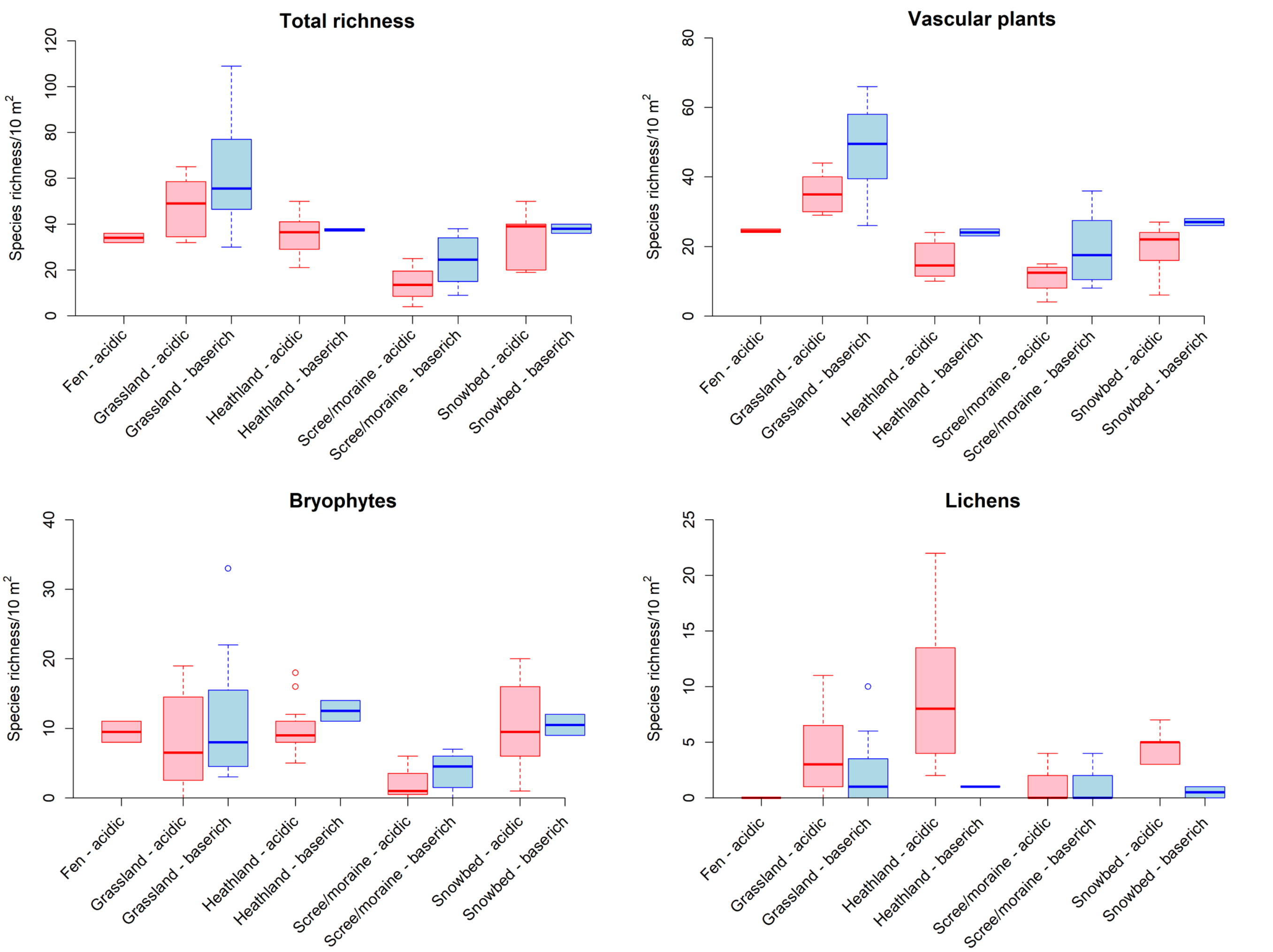

Fig. 8. Variability of species richness at 10 m², aggregated by main structural vegetation types and differentiated according to bedrock chemistry.

https://www.swissbryophytes.ch/) and lichens ("Swisslichens"; Stofer et al. 2019).

While all previous EDGG Field Workshops focussed mainly or exclusively on dry grasslands at lower elevations, our sampling demonstrates that widening the scope of the Field Workshops to all natural and semi-natural open habitat types of the Palaearctic (corresponding to the scopes of EDGG and GrassPlot) makes sense. There are large gaps in our understanding of diversity patterns for many such habitats, particularly those within the subalpine and alpine belts of the Palaearctic.

Author contributions

J.D. organised the Field Workshop. All co-authors helped with the field sampling and plant determination. J.D. drafted the report, I.D. prepared the climate diagrams and boxplots and H.S. the maps, while B.C.-M. composed the photo diary. All authors checked, improved and approved the manuscript.

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Appendix: Photo diary of the 14th EDGG Field Workshop

Edited by Beata Cykowska-Marzencka & Jürgen Dengler

With photos by Beata Cykowska-Marzencka, Iwona Dembicz, Jürgen Dengler, Patrick Neumann & Hallie Seiler

Day 1 (4 September 2020)

Our rather spontaneous expedition started at "Stalla Alp Glivers", the mountain hut situated on Alp Glivers at 1919 m a.s.l. This was our starting point and sleeping place for four days. During the first afternoon after arrival, we made our first two biodiversity plots, one in grazed grassland and the second in tall heathland. They were not made without difficulties – on both plots some of us had to fight with "mountain grazing animals" to keep our measuring tapes and backpacks in good (any) condition. However, our hardships were rewarded with beautiful views, pleasant company and a delicious dinner. After dinner we were joined by two friendly lichenologists from northern Germany.

Stalla Alp Glivers and surroundings.

First plot CHA01 surrounded by cattle.


Our companions on first two plots and eaters of things, not only plants. Left: plot CHA01, right: plot CHA02.

The views and company made up for the hardships.

Day 2 (5 September 2020)

The second day started with perfect weather and a delicious breakfast in our accommodation. We ascended over 600 meters, completing four biodiversity plots along the way. Some of us also refreshed themselves in a high-mountain lake, while others had to tend the goats.

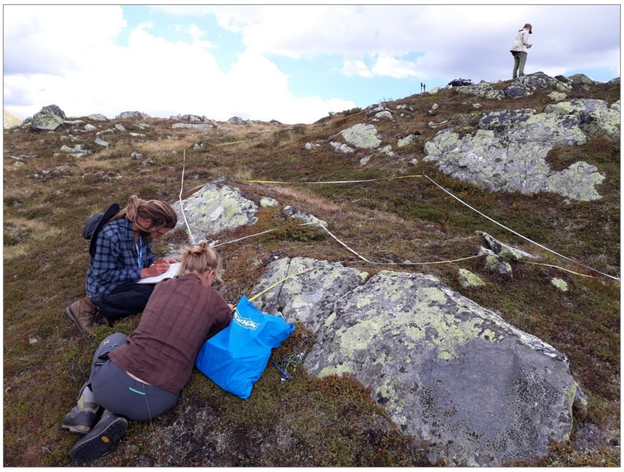
"Together forever".

Lag Serein – the perfect lake for a (short) swim. On the right in the background: Piz Ner, 2691 m a.s.l.

Our first plot was over scree.


The second location in very steep unused grassland with a view of Piz Ner, 2691 m a.s.l. (left) and the Lepontinian Alps (right).


Snowbed on the slopes below Piz Posta Biala, 2499 m a.s.l., with a view of Piz Ner, 2691 m a.s.l. (right).

Picnic time (left) and fourth plot in a low-grown heathland (right).

Day 3 (6 September 2020)

The third day we started with fog and one of the steepest localities during this trip. Because weather forecast had predicted rain, we decided to make plots in the vicinity of the hut. We chose a tall heathland on a steep south-facing slope and a fen as our two plots. In the afternoon a storm came, offering us time to eat calmly in the hut and to identify a lot of material, including one liverwort species new to Switzerland.

Sampling the steep plot in a tall heathland (CHA07).

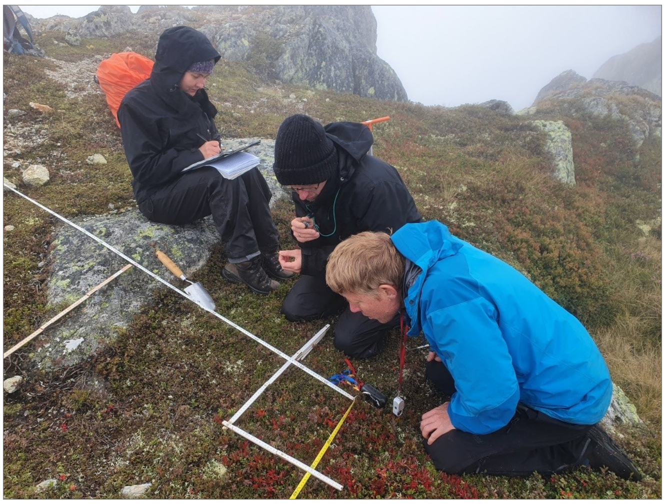
Sampling in an acidic fen (CHA08).

A perfect dinner and identification.

Day 4 (7 September 2020)
On this day hardly any rain was forecasted, but essentially we stayed inside a cloud the whole day, leading to quite cool and humid conditions. We had to use all our clothes and to move a lot to survive. Nobody was thinking about swimming in a lake. A big surprise was the result of this hard day: five completed plots – more than on any other day!


First plot of the day in a tall heathland (CHA09).


Second plot the day in a snowbed (CHA10).

Sampling low-grown heathland at a summit below Piz Avat, at 2170 m a.s.l.


Good picnic and explaining lichens can make you happy.


Tall heathlands with a dominance of *Rhododendron ferrugineum* and *Juniperus communis* subsp. *alpina* (plot CHA12).

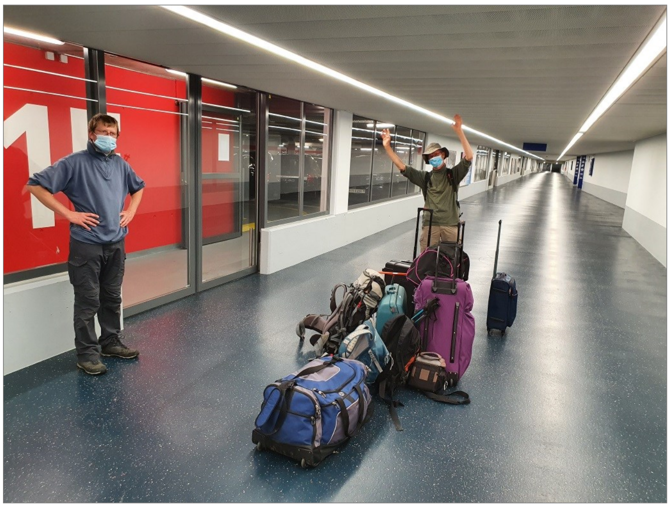

Views from the few moments when the fog lifted.


After a short break for a hot coffee and cake, we made one more plot in grazed grassland, just below the hut (right). One of us was quite eager to work despite the biting cold (left).

Day 5 (8 September 2020)
With the fifth day, the second part of our expedition started. Unfortunately, two persons left our group: Hallie had to go to work and Timon had to continue his personal research. We left Alp Glivers and travelled from Grisons to Zermatt in Valais. We drove via two of the highest passes in Switzerland: the Oberalppass (2046 m a.s.l.) and Furkapass (2436 m a.s.l.). Zermatt welcomed us with beautiful, sunny weather. During the first afternoon, we settled into our lodgings and made three normal (10 m^2) plots in dry grasslands in the Zmutt valley above the town.

Last view from Stalla Alp Glivers (left).

Oberalppass (2046 m a.s.l.) (left) and Furkapass (2436 m a.s.l.) (right).



To reach Zermatt, we had to leave our cars in Täsch and travel by train. Zermatt is a town without private car transport. Due to the pandemic, Zermatt was almost empty (right).

An afternoon spent sampling 10-m^2 plots in dry grasslands with a view of the Matterhorn (4478 m a.s.l.).

Left: evening impression from the Zmutt valley. Right: it's impossible to visit Switzerland without eating some form of melted cheese. In the evening we thus prepared cheese fondue in our rented flat.

Day 6 (9 September 2020)

The weather was still perfect, like during summer. We hiked west of Zermatt into the Zmutt valley, enjoying plenty of views of the Matterhorn all day. Probably we took the most pictures during this day. We made three plots over base-rich grounds: one on a moraine, one on a scree and one in high mountain grassland. During the way we learned a lot, not only about plants, but also about grasshoppers. After this day we had to say goodbye our two super nice lichenologists – Christian and Patrick.

On the way to our first plot, we took the "Kulturweg" with many old, traditional houses and beautiful views.

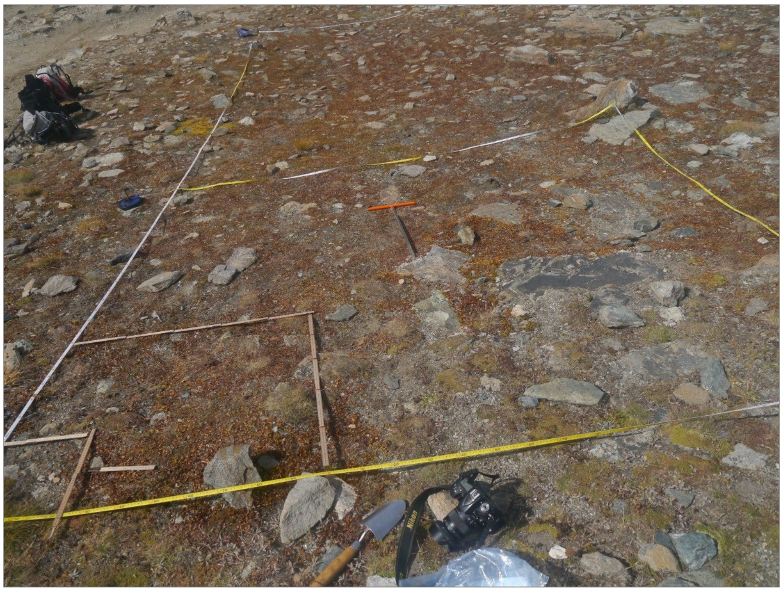
Our plot on moraine (CHA14) (left) and goodbye with Christian (right). Both of our lichenologists, Christian and Patrick, moved on for a BLAM meeting.

Left: second plot on a scree (CHA15). Right: third plot in a grassland (CHA16).

Day 7 (10 September 2020)

The last day in Zermatt welcomed us with clouds and cold. We decided to take the train to Gornergrat and probably made the highest complete EDGG Biodiversity Plots in the European Alps so far. It was difficult to concentrate on our work with such beautiful views! At the end of this day, we travelled back to Wädenswil.

The surroundings of our research plots were noble today. Left: Toblerone, oops sorry – Matterhorn, 4478 m a.s.l. Right: Dufourspitze, 4637 m a.s.l., in the Monte Rosa Massif, the highest mountain of Switzerland.



The highest plot from the expedition, 3084 m a.s.l., on a scree (CHA17) and the second highest in a snowbed at around 3000 m a.s.l. (CHA18) (right).


While we were working in the snowbed plot, many people asked Susanne what we were doing, and she answered in three languages! She is the best!


No matter how beautiful the view, you still need to eat! Picnic before the third plot.

Way back with obligatory masks and later a small disinfection.

Day 8 (12 September 2020)
On this and the following two days we started from Wädenswil as base camp to the Glarus Mts., a high alpine range that can be reached by public transportation. This day, Jinghui, Jürgen's Chinese postdoc, joined the small team of Iwona and Jürgen. We sampled at Gumen above Braunwald, which we could reach, by taking two cable cars, without much walking. Only our plot sampling took too long so that for the way back, we had to replace the upper cable car by hiking as it was already closed.

The two plots of the day, left a limestone scree (despite it looks rather empty, it still contained 27 species) (CHA20), right a limestone grassland (CHA21).

Day 9 (13 September 2020)

We departed from Wädenswil and drove directly to the Klausenpass, 1952 m a.s.l. There, we left our car and hiked up the moraine of the glacier below Mt. Clariden. On this recent moraine, we could observe and record different vegetation types: moraine, snowbed and low-grown heathland. The fragments of the glacier falling into the lake were very photogenic.

Left: the glacier below Mt. Clariden. Right: sampling a moraine plot CHA22.

Our picnic in the snowbed plot (CHA23) and the last plot of the day in a *Dryas octopetala* heath (CHA24).

Our way back…

Day 10 (14 September 2020)

On our last day, we again started from Wädenswil and went to Urnerboden, where we took a cable car to the Fisetenpass, 2036 m a.s.l. We spent quite some time walking along the ridge, searching for a limestone grassland plot that we could sample without risking our lives (because of the very steep slopes).

In the cable car (left) and on the way to the “ideal” plot.

On the ridge, looking for a plot in limestone grassland (despite being over limestone, most of the grasslands were acidic here due to leaching of the top soil).

Picnic after several hours of sampling to obtain the richest plot ever (CHA25) (left) and the last plot of this Field Workshop (CHA26) (right).

Selected pictures of vascular plants

Arctostaphylos alpina

Hieracium pilosella **subsp.** ***velutina*** **(easily recognizable, ecologically and biogeographically distinct, but not yet accepted in the Swiss checklist)**

Dryas octopetala

Linaria alpina

Scabiosa lucida

Adenostyles alpina

Silene acaulis

Pritzelago alpina

Trisetum distichophyllum

Leontopodium alpinum

Primula integrifolia

Hieracium staticifolium

Campanula cochleariifolia

Selected pictures of bryophytes and lichens

Rhytidium rugosum

Sphagnum inundatum

Polytrichastrum sexangulare

Solorina crocea

Alectoria ochroleuca

Flavocetraria cucullata

Thamnolia vermicularis

Cladonia arbuscula

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